# THE NEW AGRICULTURAL STRATEGY

**The Vehicle of Green Revolution in India**

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*Foreword by*
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## FOREWORD

In 1948, as a student of the Indian Agricultural Research Institute, I happened to listen to the lectures given by eminent experts at a Seminar specially convened by the late Shri Jawaharlal Nehru to develop a strategy to achieve self-sufficiency in food by about 1951. The gap between production and need then was probably of the order of 10 percent. Each expert, depending upon his specialisation, explained with gusto how this small gap could be easily bridged, provided his suggestions were implemented. Thus, the soil scientist pleaded for soil testing and fertilizer application; the plant breeder advocated the multiplication and distribution of seeds of new strains; the entomologist wanted pests to be destroyed; and the rat expert mentioned that there would be surplus food in the country if all rats were killed. However, in spite of so many possibilities being open for a rapid solution of the problem, the food outlook for India was still described as hopeless by many foreign experts till as late as 1965. The Paddock brothers cheerfully predicted that Indians would be in the same fate from 1974 onwards as sheep being marched to a slaughter house. Where then do we stand now ?

The strategy adopted for agricultural development in independent India can be broadly classified into three phases — (i) general (1947-61); (ii) intensive (1961-65); and (iii) specialised (1966 onwards). The general strategy was reflected in the place given to agricultural advance in the Community Development Programme— the multi-purpose Village Level Worker holding the key to advances in many directions. During this stage, much of the infrastructure needed for agricultural progress, such as fertilizer, factories, roads and irrigation systems, was slowly built-up. The initiation of the Intensive Agricultural District Programme (IADP) in 1961, marked the beginning of an *approach* characterised by concentration of efforts and resources rather than their widespread diffusion. The initial phase of the IADP did not lead to the anticipated results largely due to the fact that the package of practices recommended to farmers was deficient in one important ingredient, namely, a variety

which would react synergetically with the rest of the package. It is this deficiency which was made good in the more recent phase beginning in 1966 with the initiation of the High-Yielding Varieties Programme. Not only were high-yielding varieties of wheat, rice, maize, *jowar* and *bajra* introduced in areas endowed with assured water supply, but steps were also taken to set up the Agricultural Prices Commission to recommend prices which were both remunerative to the farmer and reasonable to the consumer, and a Food Corporation which would purchase the grains produced at the prices assured by the Government. The edifice of scientific agriculture was, thus, built brick by brick and the fruits of this labour are reflected in the rising productivity of wheat, *bajra* and potatoes.

Studies by experts like Drs. P. K. Mukherjee and B. Lockwood reveal that irrespective of the size of holding, farmers in Punjab and Tamil-Nadu have been increasing the proportion of their holding allotted to high-yielding varieties. This trend is also reflected in the statewise progress made in the spread of high-yielding varieties of rice and wheat — Tamil-Nadu and the Punjab being in the lead respectively in these two crops. The reasons for the uneven progress in the spread of the high-yielding varieties of different crops have been frequelly discussed. Among the five crops originally in the High-Yielding Varieties Programme, wheat can be termed a 'low risk' crop because of an assured market, favourable prices, absence of serious pests and the decentralised water management system possible. In contrast, rice, *Jowar*, *bajra* and maize are all 'high risk' crops, exposed to many serious pest problems, marketing difficulties based on quality consideration, and to either shortage or excess of water, depending on the behaviour of the monsoon, thereby necessitating more integrated irrigation and drainage systems. Post-harvest problems are becoming serious in many crops and are today probably limiting both the spread of high-yielding varieties and fertilizer consumption. For example, some of the highest yields of maize in All-India trials are obtained in the Kulu Valley of Himachal Pradesh, but if more maize is to be grown in this area, there has to be more roof area in the houses, since this is where maize is dried.

Scientists like Dr. P.V. Sukhatme of FAO and Dr. C. Gopalan of the National Institute of Nutrition have shown that the growing problem of protein-calorie malnutrition in India, particularly among children, can be solved only by producing more and cheaper food. This is because in cereal-based diets, under-nutrition is generally the mother of mal-nutrition and under-nutrition in turn is at present largely due to inadequate productive employment. This situation leads us to ask what the next phase in the evolution of our agricultural strategy should be. In my view, the next phase should consist of a blend of a national euphenic policy and agricultural development designed for more jobs and income. Euphenics implies working for good healthy individuals and a national euphenic policy should include attention to the nutrition of pregnant and lactating mothers and infants, extension of health-care facilities in villages and promotion of inter-caste and inter-state marriages as a means of getting the maximum benefit from the genetic potential in the country (—an example of this is the small recent programme initiated in Tamil-Nadu to foster inter-caste marriages). A policy of agricultural development for more jobs and income has to be based on (a) increasing the efficiency of farming in irrigated areas, particularly through integrated pest control measures and better water management systems ; (b) development and introduction of ecology-cum-economics based crop-cafeterias in both irrigated and rain-fed regions from which the farmer can choose the crop combination which is best suited for his capacity to mobilize inputs, and market and seasonal conditions ; (c) greater attention to harvesting threshing, storage, marketing and pricing ; and (d) detailed attention both to factors which can promote employment and those which are likely to reduce the employment potential of agriculture due to developments in other fields of technology. I shall cite two examples to illustrate the last point which involves dove-tailing of research and development policy with perspective planning.

The areas characterised by the "Wheat Revolution" now face a temporary labour shortage during harvest time. Two ways are open to meet the situation — (i) mechanisation of harvesting ; or (ii) planned seasonal migration of labour from neighbouring dry farming regions. For example, it has been calculated by an expert

that to harvest 1·5 million hectares of wheat and barley, either an adequate number of combines or 50,000 tractors and wagons capable of moving 150,000 unemployed labourers can be purchased. The advantages of the latter step need hardly be enunciated, since it will not only provide employment and expose the migrating labour to the secret of good crops, but it will also provide tractors for other agricultural purposes.

An example of the potential threat to employment in the future, in dry farming regions, is the possibility of displacement of cotton by synthetic fibres endowed with easy-care properties. For example, in Brazil (— a major cotton growing country), cotton consumption increased by only 30 thousand bales during 1961-70, while the the consumption of man-made fibres increased by 210 thousand bales during the same period. Production and processing of cotton are both labour-intensive and remunerative. What will be the fate of some of our dry farming regions producing cotton, if a similar development takes place ? The research answer to this problem is to quickly breed varieties of cotton which respond well to physical and chemical processing methods which confer on them easy-care traits which are the characteristics of polyester, nylon and polynosic rayon fibres. The sooner we start thinking on these lines, the greater is the possibility of the predictions of Paddock Brothers proving false.

It is in the above context that I consider the present book timely and useful. Shri Daya Krishna deserves the gratitude of all those interested in Indian agriculture, for his painstaking efforts in compiling data and information from so many scattered sources and making them available in a concise and readable form.

**M.S. SWAMINATHAN**

15th August 1971,
Indian Agricultural Research Institute,
New Delhi.

# PREFACE

The *kharif* season of 1971 marks the beginning of the sixth year of the working of the New Agricultural Strategy (N. A. S.) in India.

The introduction of the N. A. S. from the kharif season of 1966 had started a new trend in the production of foodgrains, and, after the rare sequence of four bumper crops in a row, the level of foodgrains production in India reached the all-time record of 108 million tonnes in 1970-71. And, but for the floods in the north and droughts in the south, the country appears well set for achieving the target of 113 million tonnes set for the year 1971-72.

It may be true that some proportion of the increase in foodgrains production achieved in the past four years is attributable to the favourable weather conditions; but, for a good proportion of the increase, credit has to be given to the *approach* underlying the N. A. S. This is amply borne out by the fact that despite none-too-favourable weather conditions for rabi crops in certain areas, the production of wheat has been going up steadily.

Some observers of the agricultural scene in India use the term "Green Revolution" for describing the unusually large increases in production of foodgrains recorded after 1966-67; but, the *green* of the country is not yet prominent enough so as to justify use of the word 'revolution' with it. As a matter of fact, working of the N.A.S. is confined only to about 1/10th of the total cultivable land in the country and the remaining 9/10th of the land still lies outside its scope. Also, a marked success of the N. A. S. is, as yet, confined to one crop only, i.e. wheat. But, then, these are precisely the arguments that seem to make the N. A. S. all the more important. If, with 1/10 of the land as its operational base and major success in one crop only, the N. A. S. can promise self-sufficiency in foodgrains by the end of 1971, then there must be *something* in it that merits close observation aud detailed consideration.

For a clear understanding of the working of the New Strategy it is extremely important to know as to what is "New" about it; what are its chief components; how they came to be evolved; what is their importance; and in what manner they operate ? There are several problems confronting the N. A. S.; but, then there are problems created by the N. A. S. For instance, in Punjab and Haryana, the flow of market arrivals has risen to about five times the storage capacities in the mandies because of the substantial increases in production and the much faster pace of arrivals due to mechanised harvesting and threshing. As the technologies in regard to the post-harvest operations viz. storing, transporting marketing and processing have not been developed adequately, in june 1971, an unseasonal and unwelcome (?) round of showers damaged wheat worth hundreds of crores of rupees. The main purpose of this book has been to help in acquiring an adequate understanding of the working of the N. A. S. and to find answers to the various problems mentioned above.

The first and foremost comes the question as to what is "New" in The New Strategy ? Apparently, the N. A. S. is different from the earlier Grow More Food (G.M.F.) approach mainly on three points, viz, (i) the selective approach; (ii) use of new seeds; and (iii) incentive price.

The approach underlying the N. A. S. can be called "selective" because of its operation having been confined to certain selected areas only. Whereas, under the earlier G.M.F. approach, the available resources of inputs and technology were dispersed over wide areas, without any consideration for their respective potentials for growth, efforts are being made in the N. A. S. for a planned deployment of scarce resources on those areas only as are known for their higher potentials.

The most important single factor that makes the N. A. S. different from the earlier G.M.F. programme is the use of newly evolved seeds of High Yielding Varieties. In fact, the new seeds are the "crucial" factor without which all other components of the N. A. S. become infructuous.

Another important factor in the approach under the N. A, S.

is the concept of "incentive price". After the First Plan period, the idea started gaining ground that the prevalent state of near stagnation in the production of foodgrains was largely due to the existing low level of prices, which could offer no incentives to the farmers for raising their production. The Third plan clearly emphasised the necessity of assuring to the farmers, certain minimum remunerative prices, in order to provide the necessary incentives for inereasing production. This concept of "incentive price" which was put into practice towards the end of the Third Plan period, marked a deviation from the policy of "holding the price line" emphasised in the First Plan.

The book has ten chapters, arranged according to a definite order. The first three chapters of the book are devoted to a detailed consideration of the above-mentioned three distinguishing factors of the N. A. S. The fourth chapter gives detailed information in regard to the eight constituents of the infrastructure, viz. credit, marketing, storage, research, education & training, power, transport & communication and administration. The next three chapters in the book deal with inputs other than seeds, viz. water, fertilizers and pesticides, in that other. The last three chapters give detailed information on the genesis and working of the programmes of

1. Multiple cropping;
2. Dry land farming; and
3. Small farmers.

The last mentioned three programmes have been taken up primarily for the weaker sections of the rural population which have not been able to partake of the benefits of the N. A. S. The selective approach underlying the N. A. S. has benefited mainly those areas which already had the advantage of irrigational facilities and other areas have remained outside its scope. As a result, the rich farmers are becoming richer and the poor have remained poor. This widening of the gulf between the rich and the poor, or the problem of growing disparity in the society is a "fall-out" of the N. A. S. If effective corrective measures are not taken in time, it is feared that the New Seeds may prove to be the seeds of New Conflicts in the country.

The break-through in the production of wheat has gone a long way in restoring our confidence in our capacity for doing things and emboldens us to meet the new challenges ahead. The present climate of confidence, however, bears a sharp contrast with the situation during the drought years of 1965-67, when even our friends abroad had considered it inexpedient, or even impossible, to help India out of its seemingly intractable and unending problems of mass hunger, poverty and starvation. It is mainly because of the accomplishments of the N. A. S. that we are able to raise our sights and look forward to the future with a sense of confidence and hope.

This book has been attempted for all those associated with agriculture, directly or indirectly, and it is hoped that it will also prove of much interest to the common man, who is rather anxious to know about the potentialities of the new technologies for banishing hunger and poverty from India.

The contents of the book are essentially of a technical nature. Several technical papers prepared by eminent persons known for their expertise in the field have been extremely useful in the preparation of this book and for this I am very much indebted to their authors. These papers have been mentioned in the bibliography.

Certain inferences and observations made here and there in the book should be considered as my personal views in the matter.

**Daya Krishna**

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I am very much indebted to Shri Kamla Prasad, under whom I have the privilege of working in the Foreign Aid Division, for the great encouragement and inspiration I received from him for the writing of this book. I am sure, this book would not have seen the light of the day, but for his deep and abiding interest in the subject and a generous appreciation of any work connected with it.

I am very much grateful to Dr. P. S. Bhatnagar, Director Farm Advisory Unit in the Department of Agriculture, who spent much of his valuable time in going through the manuscripts of the book and making necessary modifications, wherever necessary. It is because of the labours of Dr. Bhatnagar that the book bears the imprints of the hands of an expert. Mr. H L. Chawla, Specialist, Farm Management, exhibited a keen interest in the progress of the book and gave me valuable advice from time to time. I will be ever grateful to him for that. I am also grateful to my friend Mr. N. Ramamurthy, Research Officer, for his valuable comments on the book.

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## CONTENTS

# 1

# The New Strategy

For about three decades or so, India has been striving hard to achieve self-sufficiency in foodgrains. Several approaches were tried and a multiplicity of programmes undertaken ; but, the goal of self-sufficiency, like a mirage, though visible distantly, kept the distance through. In addition to the prevailing conditions of overall scarcity in the country, there occurred two famines during this period — one in Bengal in the year 1942 and the other in the adjoining State of Bihar during 1965-67. These famines, causing human suffering on a wide scale, succeeded in bringing into a sharp focus, the endemic problem of food scarcity in the country and the imperative necessity of achieving self-sufficiency in foodgrains. Although the two famines, occurring in the same part of the country, were quite comparable in their severity and consequences, they differed in one important aspect : whereas the Bengal famine of 1942 marked the beginning of a search for "what to do and how", the Bihar famine of 1965-67 forced the pace of the formulation and implementation of 'The New Agricultural Strategy' which aimed at making India self-sufficient in foodgrains by 1971.

The main plank of The New Strategy for increasing agricultural production in India has been the cultivation of High-Yielding Varieties of foodgrains which was started from the Kharif season of 1966. As a consequence, the area under HYV of foodgrains increased from less than 2 million hectares in 1966-67 to over 15 million hactares during 1970-71. Increases in the area under HYV of foodgrains, through pushing up the per unit area yields, made substantial additions to overall production of foodgrains in

the country. Assisted by continuing spells of favourable weather conditions, the production of foodgrains in India reached in 1970-71 the all-time record of 104 million tonnes which was more than double of the 51 million tonnes produced in 1950-51. This indicates a rate of increase of over 5% per annum during the twenty years ending 1970-71. But the average annual rate of increase was not uniform : it declined from about 6 percent in the First Plan to nearly 3 percent in the Third Plan, and, thereafter, it again rose to about 4 percent in the next five years period ending 1970-71, the great downward fall of the two drought years notwithstanding. The trends in foodgrains production during the period 1950-51 to 1970-71 are indicated in the graph on the opposite page. A close observation of the graph brings out three important facts :

1. The level of foodgrains production in the country had a generally rising tendency since 1950-51, except for a small decline in 1957 58 and a substantial fall during the drought years of 1965-67 ;

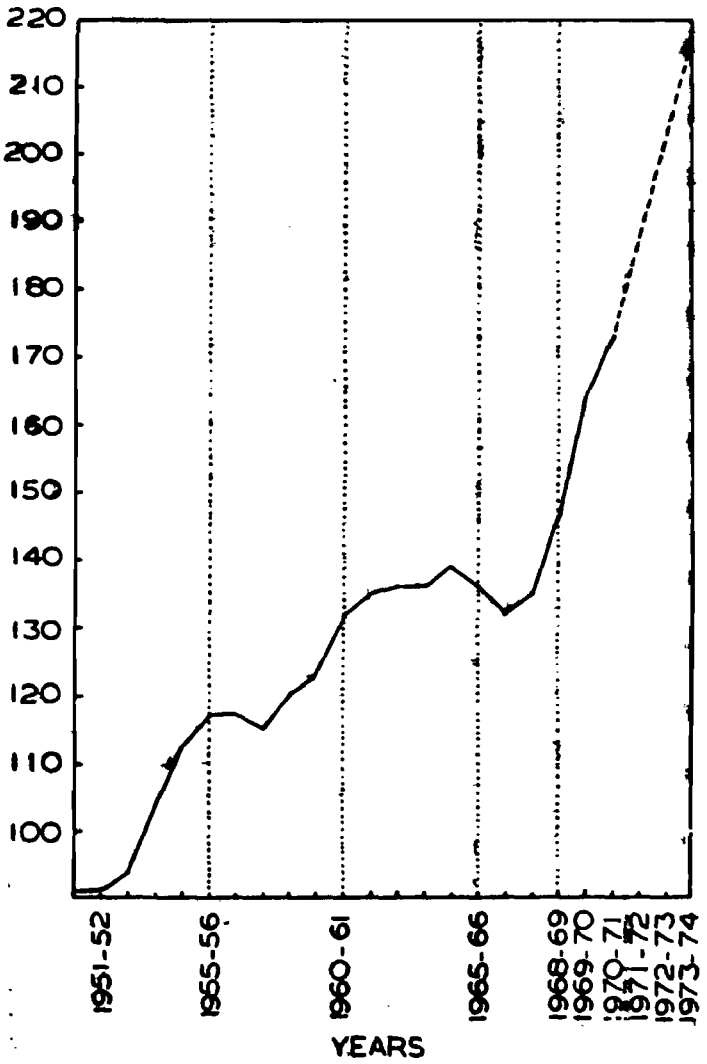
2. During the First three Plans, the production of foodgrains was rising with a steadily declining rate of increase ;

3. The rate of increase after the drought years was the highest since 1950-51.

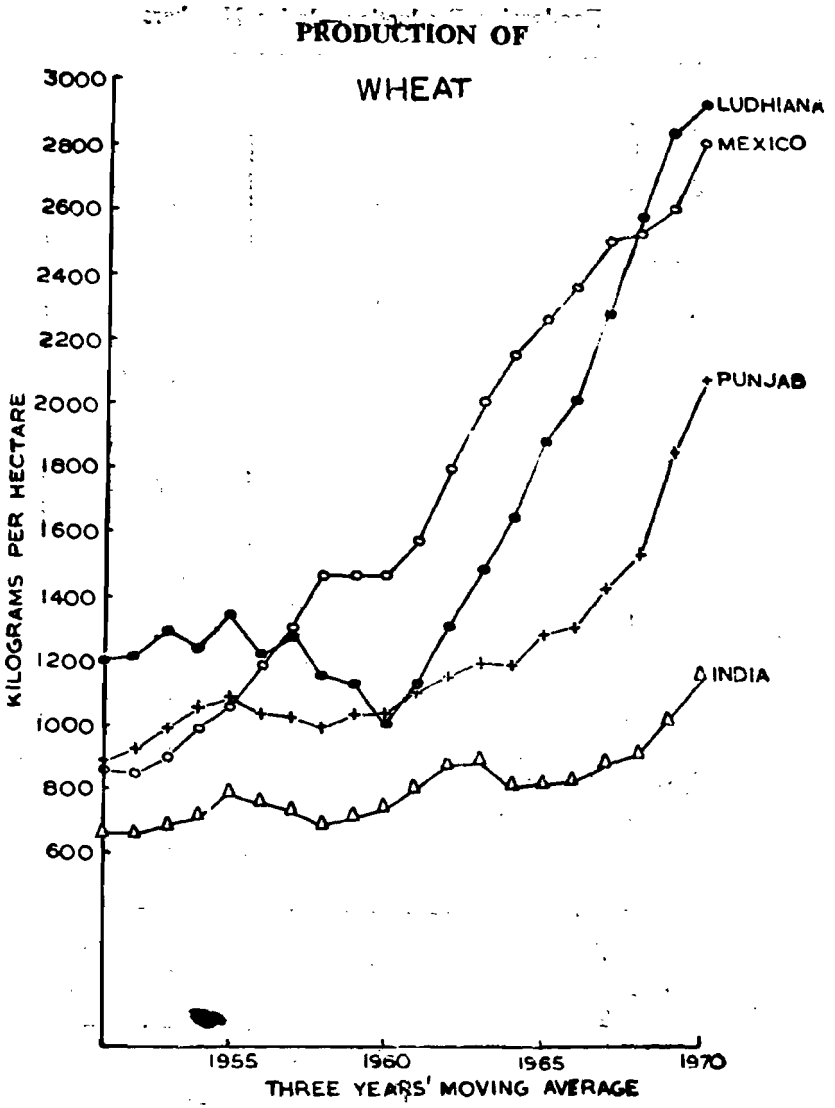
The high rate of increase in the foodgrains production obtained during the First Plan period was mainly due to the great emphasis laid on agriculture and also to the favourable weather conditions. After the First Plan period, however, agriculture no more remained "the most favoured child" in so far as the financial allocations were concerned and also the old Dame Weather became frugal with its favours. Consequently, the various programmes taken up under the G.M.F. Campaign failed to achieve any appreciable results and during the Third Plan period, agriculture reached a stage of near stagnancy. A detailed account of the working of the various G.M.F. programmes before the advent of The New Strategy is given later in this chapter.

The steep rise in the production curve after 1966 is attributable largely to the steadily improving yield rates brought about by the cultivation of High Yielding Varieties (HYV) of foodgrains under The New Strategy. The trends in the yield-rates of wheat are

Foodgrains Production—Index Numbers




(Three Year's Moving Average)


PRODUCTION OF
WHEAT
LUDHIANA
MEXICO
PUNJAB
INDIA
KILOGRAMS PER HECTARE
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
1955
1960
1965
1970
THREE YEARS' MOVING AVERAGE

indicated in the graph on the opposite page.

It will be seen from this graph that whereas the yield 'take off' started in Mexico from 1952 onwards, yields in India started looking up only after 1966 *i.e.* when the cultivation of HYV of foodgrains was introduced. With gradual extension of the area under HYV, there occurred a steady improvement in the all-India average for per hectare yields of wheat. In Punjab, where the proportion of area covered by HYV is the largest, the improvement in yield rates is more impressive as compared to the improvement in the all-India yield rates. Ludhiana district in Punjab, which has the largest area of wheat under the HYV, excelled even the yield rate for Mexico which is the progenitor of wheat revolution in the world.

Ludhiana is only one of the 338 districts in India and was one of the seven districts selected in Punjab for the implementation of the "Package Programme" there. It was primarily selected for improvement in wheat production. Of the 480 thousand hectares of total cropped area in the district, about 3/4th has irrigational facilities. Of the total irrigated area, about 5/6th is irrigated by minor irrigation works *i.e.* percolation wells, pumping sets and tubewells and the remaining 1/6th by the Government canals. Wheat, maize, groundnut, cotton and sugarcane are the major crops of the district. Farmers in about 600 out of the 900 villages in the district receive training from the officials through the various training camps organised at suitable places. This is the only district where the farmers are virtually flooded with literature in the regional language, on food production technologies. No wonder, therefore, if Ludhiana holds, since 1966-67, the world record in per hectare production of wheat.

Besides Ludhiana, there are also several other districts in the country, which are harvesting bumper crops by sowing the HYV seeds and are pushing up the production of foodgrains year after year. In Punjab, the production of wheat, estimated at 4·91 million tonnes in 1970-71 was merely two and half times of the production of 1·92 million tonnes recorded in 1965-66 In Haryana, the production of wheat doubled up from 0·87 million tonnes in 1965-66 to 1.75 million tonnes in 1970-71. The all-India production of wheat also increased from 10 million tonnes in 1965-66 to about 22 million tonnes in 1970-71.

## A WIND OF CHANGE

Because of the large increase in the production of wheat and the prospects of a break-through in other crops also, a wind of change is beginning to blow over large tracts of land in the country. The spectacle of transformation is visible in vast areas of Punjab, Haryana, Delhi and Western U.P. in the wheat belt and in large rice-producing tracts of Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra, Mysore and Gujarat. An indication about the extent of this transformation is provided by the extra-ordinary increases in the demands for various agricultural inputs. In the early sixties, the rate of increase of the application of agricultural inputs was painfully slow : the targets were rarely achieved and surplus stocks was a common phenomenon. There were in the country, 4 to 5 million acres of land which was irrigable, but, was not actually irrigated because of mere want of initiative on the part of the farmers to link up their farms with the main arteries of water. Manufacturing of agricultural implements never appeared to be a profitable enterprise. Though there were no high-yielding varieties of seed, whatever improved varieties were there, were not found to be in great demand. In the later sixties, however, the position changed appreciably. Though supplies increased, demand out-stripped the supplies everywhere. As a result, there were reports of premiums being paid for the supply of the important inputs of agriculture *viz.* fertilizers, tractors and improved varieties of seeds.

The entire perspective of the whole range of problems in the field of Agriculture underwent a change. There was a time when most of the States were opposed to any relaxation in the zonal system. But, a time came when those very States were imploring the Centre for removing the zonal system altogether, or for extension of the zonal barriers, so that their produce could fetch a higher price in the distant markets. The States which would not permit Food Corporation of India to function effectively in their territories, offered red-carpet treatment to them a few years later. Because of the fall in the price level, the procurement prices in various States became the support prices, in due course of time. Obviously, the procurement prices were fixed for the purpose of

making procurement only and not for giving support to the falling prices. Previously, the stress was on preventing fragmentation and sub-division of holdings in the country ; but, later on, the emphasis shifted to the task of making the small farms viable because they were also considered to be capable of playing a role in augmenting the agricultural production in the country. Instead of the earlier problem of all-pervading poverty in the rural areas, there emerged the problem of "increasing gulf between the rich and the poor". The problem of indebtednesss in the rural areas was considered to be a very vicious problem a few years back. But, this problem receded in the background and, instead, there emerged the problem of "mopping up of the savings" in the rural areas. The most important problems in agriculture now are those relating to storage, transportation, credit and marketing. And these are essentially the problems of growth.

The New Strategy which was first put into practice during the kharif season of 1966, through cultivation of HYV of seeds consisted in a planned deployment of the limited resources of inputs and technology over certain selected water-assured areas of the country, with a view to maximising the production of foodgrains. Use of the High Yielding Varieties of seeds is the king-pin of this strategy. The broad objective of this strategy is to obtain the largest possible increase in agricultural porduction in the shortest possible time, so as to achieve self-sufficiency in foodgrains by 1971.

The New Strategy was not evolved overnight : The efficacy of some of its ingredients, as effective means for raising farm yields, had been realised and emphasised much before its implementation in 1966. The importance of "Intensive Cultivation" approach which forms the basis of The New Strategy had been receiving emphasis since 1951 onwards. Similarly, efforts were also made from time to time for popularising the other ingredients of The New Strategy *viz.* use of improved seeds, fertilizers, improved implements and plant protection measures etc. The *crucial* factor in the New Strategy, however, is the use of high yielding varieties of seeds. In the words of Dr. P.B. Pal :

> "In the beginning of the sixties, not much progress was in evidence in improving the productivity of our major crop

plants in spite of the initiation of the Intensive Agricultural Development Programmes (IADP) ; but, towards the end of the sixties, the position had changed dramatically. This is because the key-factor which was missing in the package included earlier in the I.A.D.P. district has been identified and included in the practices now advocated. This missing factor was found in the new high-yielding varieties and hybrids capable of utilising effectively both solar energy and chemical fertilizers and of responding to good water management. Experience gathered in the HYV programme showed clearly that, given a suitable plant type and developmental rhythm, there were immense potentialities for yield, making full use of Nature's generous endowments of water and sunlight to us. Because of the introduction of genetic factors conferring an insensitivity to length of day into the make-up of our varieties, old ideas and the adaptation of varieties had to be given up. In the irrigated areas we have started measuring productivity per day and not merely per crop. We have also come to appreciate better than in the past, the fabulous plant wealth of our country expressed by the occurrence in our country of a large number of plant species, than what one finds in countries with a much larger land mass".

The evolution of these high-yielding varieties also was not the work of a year or two. The Indian Plant Breeders assisted by foreign experts and agencies took about a decade and a half for evolving varieties suitable for Indian conditions.

Apprehensions about the inability of Indian farmers to take up to the new technologies was also considered a great inhibiting factor. It had long been supposed that subsistence farmers everywhere, including those in India, were too sluggish, too unintelligent and too much tradition-bound, to use any new technology or inputs. But, Indian farmers, once they were given something better to work with, and were convinced that it really was better, amazed not only their Government, but also the rest of the world. They proved too eager to try anything new, if it had good prospects of producing more yield, and if prices were such that they would be appropriately paid for what they raise. In other words, they proved as good farmers as could be found anywhere in the world.

The speed with which India's farmers and scientists with some materials and counsel from the outside, suddenly showed their country the way to bountiful harvests had never been duplicated on

an equal scale anywhere else in the world, including the agriculturally sophisticated United States of America. And that Indian farmers did it under great handicaps is a great tribute to their capacity for hard work and intimate knowledge of the intricacies of their profession.

## THE WATERSHED

In addition to the 'New Seeds' which formed the *crucial* factor, an important feature of the New Strategy has been the adoption of **selective approach for the cultivation of** New Seeds. Before 1960, 'Intensive Cultivation' was only one of the various means for increasing agricultural production in the country. From 1960 onwards, however, 'Intensive Cultivation' became the basic plank in all programmes for agricultural development. Whereas, before 1960, the available resources of inputs and technology were dispersed over wide areas, without any consideration for their respective potialilities for growth, after 1960, planned efforts were made to concentrate the resources in certain selected areas only. The pre-1960 approach, which was essentially the G.M.F. approach could be described the "Extensive" approach because of the involved efforts for the gradual extension of certain measures over larger and larger areas without any consideration for the differences in their potentials for growth. The post-1960 approach, on the other hand, could be described as the "Selective" approach because of the planned use of resources on areas selected on account of their higher potentials for growth. The year 1960, thus, marks the change from the 'Extensive' to 'Intensive' approach and for this reason it can be considered to mark a watershed This change from the 'Extensive' to the 'Intensive' approach can be attributed largely to the two very important reports by Ford Foundation Teams which have been dealt with separately, later on.

## THE G.M.F. PROGRAMME

A careful perusal of the G.M.F. programmes shows a gradual shifting of emphasis from the Production Programmes to Community Development Programmes During the pre-1960 period, the G.M.F. Programme had formed the basic approach for all programmes of agricultural development in the country. The "Grow More Food"

campaign was launched in 1942, as the first 'Planned Drive' for increasing production of foodgrains in the country, after the deliberations of the "Food Production Conference", which had recommended the following measures for bringing about an improvement in the then "Critical" food situation of the country :—

1. Increasing the areas under food and fodder crops through reclaiming new land, double cropping and diverting land from non-food crops.
2. Increasing the supply of water for irrigation by improvement and extension of existing irrigation canals and construction of new wells.
3. Extending the use of manures and fertilizers ; and
4. Increasing the supply of improved seeds.

The above mentioned four measures constituted the basic planks of the G.M.F. campaign which consisted mainly in formulating general programmes of development for the creation of additional facilities, such as irrigation, soil-conservation, land reclamation and development, and measures for increased distribution of material inputs, such as fertilizers, improved seeds, etc. for creating additional production potentials. The targets of production were prescribed for different crops, taking into account the additional production potential thus expected to be created over assumed base levels. Special programmes for commercial crops were also drawn up, taking into account the special problems of each crop. The efforts were, however, generally dispersed over large areas.

Under the early G.M.F. approach, though efforts were made to propagate 'Intensive Cultivation', the attempts made by the Government for increasing foodgrains production were largely confined to enacting legislations and taking executive actions for transfers of lands from cash crops to food crops.

There were frequent changes in the objectives of the G.M.F. campaign and also shifts of emphasis from one measure to the other, according to the exigencies of the situations. In 1949, the G.M.F. campaign was assigned the target of achieving self-sufficiency in foodgrains by March, 1952. After about one year only, that is in

June 1950, the target of achieving self-sufficiency by March, 1952, was modified to that of achieving "relative self-sufficiency" because of the sudden emergence of difficulties in importing cotton and jute from Pakistan. Under the concept of "relative self-sufficiency", it was conceded that some imports could be neccessary for meeting emergencies such as widespread failure of crops for replacements due to diversion, and for building up of reserve stocks of foodgrains. This programme for the achievement of "relative self-sufficiency" was given the name of "Integrated Production Programme".

In the course of implementing the "Integrated Production Programme", it was realised that even the ideal of "relative self-sufficiency" in food was rather difficult to achieve in a country where masses of population were under-fed and even a small increase of production and of incomes led to a substantial increase in consumption. Even the basic assumption of a "fairly stable level of food consumption" which was implicit in the earlier self-sufficiency scheme was not found to be valid because it was not possible to control the consumption of large sections of the population, especially the millions of producer-consumers in the country, even in a period of rationing, as it obtained at that time. Seasonal variations in production also turned out to be very substantial. Moreover, the new Integrated Production approach involved diversion of lands, fertilizers, etc. from foodgrains to cotton and jute. The small additional production that was achieved was also not reflected in procurement, as it was dispersed over large areas. The dependence on imports, therefore, continued and during the year 1951, India imported 4·7 million tons of foodgrains. Moreover, the total quantity of agricultural inputs *e g.* fertilizers and improved seeds which were distributed under the G.M.F. campaign was very small and covered only a very insignificant proportion of the total cultivated area under foodgrains.

With a view to achieving the maximum benefit from the limited supplies of inputs, an important change in the G.M.F. campaign was made in 1950-51. Instead of spreading the G.M.F. efforts thinly all over the country, an attempt was made to concentrate G.M F. efforts in compact areas called "Intensive Cultivation Areas". In the case of minor irrigation schemes, compact areas

were to be selected and irrigation works so concentrated there that at least a major portion of the cultivated areas could be brought under irrigation. The land reclamation and land improvement schemes were also to be carried out only in such areas as were most suitable for this type of work. Simultaneously with this change in approach, efforts were continued for finding out the defects in the G.M.F. approach and to remove them.

In February, 1952, the Government of India appointed the Grow-More-Food Enquiry Committee to examine the working of Grow-More-Food campaign. The Committee came to the conclusion that, on the whole, the G.M.F. campaign had not achieved the anticipated results, nor aroused the expected enthusiasm in the country-side. The Committee observed :

> "the problem of food production was a much wider one than the mere elimination of food imports. It is the bringing about of a large expansion of agricultural production that will ensure to an increasing population, progressively rising levels of nutrition. Agricultural improvement is an integral part of a much wider problem of raising the level of rural life."

Among the more important recommendations of the Committee were :—

(*i*) The setting up of a country-wide extension service organisation ;

(*ii*) The acceleration of minor irrigation programmes ; and

(*iii*) the provision of adequate rural credit.

## COMMUNITY DEVELOPMENT PROGRAMMES

The main purpose of the extension service organisation recommended by the Grow-More-Food Enquiry Committee (19 2) was to raise the level of rural life through building up Community Development Programmes. Some important work for building Community Development Programmes had already been initiated by the Government even before the said recommendation of G.M.F. Enquiry Committee. A model scheme had been prepared by the Central Ministry of Food and Agriculture for the intensive development of groups of villages. This scheme, which was at first called the "Intensive Development Area" Project, envisaged the compre-

hensive development of Agriculture, Animal Husbandry, Public Health and Cooperation in selected groups of villages. Each of these pilot projects was to cover about 100 villages and 15 such projects were started early in 1952, with financial assistance from the Ford Foundation. A few months later, the scheme of "Community Projects" was developed largely on the basis of this earlier experiment. In these "Community Projects", however. much greater emphasis was laid on health and education. Rural industry was also added as a new item. Every "Community Project" was to cover three blocks of 100 villages each. In these new Projects, the emphasis was more on integrated development of Community life rather than on increase of agricultural production and marketed surplus which characterised the earlier "Intensive Development Area" schemes.

The recommendations of the Grow-More-Food Enquiry Committee of February, 1952, were incorporated into the programme for agricultural development included under the First Plan. It was specifically laid down in the Plan that the proposed targets of food production were to be realised not only through the Grow More Food schemes, but, also through major and medium irrigation projects and through the programme of Community Development and National Extension Service projects. The G.M.F. Enquiry Committee had placed a great emphasis on the Community Development Programmes, because, according to them, the Grow-More-Food campaign was of direct benefit to those cultivators only who owned land and other sections of the rural population, including agricultural labour, remained neglected in so far as the benefits from the campaign were concerned. In the year 1952-53, 55 Community Development Projects (or 165 Blocks) were started and by 1955-56 the number increased to 372 Community Project Blocks and 616 National Extension Service Blocks.

It can be seen from above that although the policy of concentrating efforts or 'intensive cultivation in selected areas with assured water supply and suitable soil was tried in the early years of the Plan, there was, subsequently, a shift in emphasis in favour of the community development projects. This shifting of emphasis occurred when food position showed signs of improvement, and

followed the recommendations made by the Grow-More-Food Enquiry Committee which considered the problem of agricultural development only as a part of the wider problem of village development. From the point of view of food production, however, there was a fundamental difference between the old "Intensive Cultivation Areas" and the new community projects. The objective of the former was to facilitate the procurement of surplus foodgrains; but, after the relaxation of controls in 1954 and abandonment of procurement, the emphasis in the Community Projects shifted from measures for increasing agricultural production and marketable surpluses in selected areas to the measures for increasing the general level of production and the well-being of the community as a whole.

With the shifting of the emphasis in the Community Development Programmes, the programmes for increasing agricultural production did not get proper and adequate attention. The activities undertaken in the Community Development Projects were integral part of programmes in the respective sectors of development, concerning various different Development Departments in the States. Except for the minor irrigation programme and, to a small extent, land-reclamation for which special funds had been provided in the schematic budget of the Community Development Blocks, no separate funds had been provided for other types of agricultural activities and all the essential supplies distributed *e.g.*, fertilizers and seeds, came from the normal Grow-More-Food Programme of the States. Although the Community Projects were supposed to be the principal agencies for creating the psychological climate necessary for increasing agricultural production, in many cases, the Project Officers concentrated attention on works programmes. The Community Projects were, however, found to be costly, and a comparatively less expensive programme called the National Extension Block was evolved in 1953 for supplementing their activities.

## THE JAPANESE METHOD OF PADDY CULTIVATION

During the period of the G.M.F. approach, a programme of particular significance was the one aimed at popularising the Japanese method of rice cultivation which can be considered a further step in the direction of the evolution of the New Strategy of

Agricultural Development because of its being based on a "non-traditional" technique of sowing and its emphasis on the use of seeds, fertilizers, water, and plant protection measures.

During 1951, an Indian delegation which had visited Japan, returned greatly impressed by the high rice yields obtained there. During the year 1952-53, the Japanese method of rice cultivation was given a trial at several places. The trials produced encouraging results and the yield of paddy obtained in the trials was found to be 4 to 6 times the yields obtained otherwise. It was felt that a considerable scope for increasing yield rates of rice existed in India under the Japanese method of cultivation. The salient features of the Japanese method of rice cultivation were :—

1. selection of good and heavy seeds for sowing in the nursery after treatment with fungicide ;
2. use of low seed-rate (15 to 20 lbs. per acre) and sowing thinly in the nursery ;
3. preparation of a well-pulverized, raised and narrow seed-bed in the nursery ;
4. application of liberal doses of organic and inorganic fertilizers to the nursery ;
5. weeding of nursery beds, and careful uprooting of seedlings ;
6. transplanting of seedlings in rows, with a regular spacing of 10" × 10" with four seedlings per hill ;
7. heavy manuring of rice fields with organic manures and fertilizers ;
8. frequent interculturing of the crop ; and
9. periodically spraying of the crop against disease and insect pests.

The Japanese method advocated a low seed-rate and a thinly sown seed bed to get strong and sturdy seedlings for transplanting. The local practice was to sow 80 to 100 lbs. of seed for a broadcast crop, and 30 to 40 lbs. or even more, for a transplanted crop.

The selection of heavy seeds by steeping them in salt water was one of the factors advocated under the Japanese method. The advantage of selecting heavier seeds was that they germinated

quickly, and the seedlings were vigorous and uniform in size at the time of planting.

Raised and narrow seed-beds, with channels in between them, provided easy drainage. This was particularly desirable in areas with heavy rainfall (as the seedlings were likely to be washed away by excessive rains) or in low-lying areas, where the seed-bed would be submerged under the water. The seed-bed soil was to be well-pulverized and timely weeding of the nursery done. In manuring of the seed-beds, emphasis was to be more ont he organic rather than on the inorganic nutrient, as a thick layer of organic manure mixed with the top-soil made it friable and facilitated pulling of seedlings.

The spacing and number of seedlings per hill depended on the variety, type of soil and time of planting. In India, bulk-planting is usually done with 4 to 5 seedlings and, in some cases, even 8 to 10 seedlings per hill. The spacing between the plants varies usually from $6 \times 6$ to $9 \times 9$ inches, depending upon the duration of the variety. The Japanese method advocated planting of seedlings in straight rows with 10—10 inches spacing between plants, which helped in easy interculture without any damage to plants. However, for early varieties (120 days or less) a spacing of 10 inches between rows and 4 inches between plants, with 3 to 4 seedlings per hill, and for late varieties, a spacing of 10 inches between rows and 6 to 8 inches between plants with 2 to 3 seedlings per hill, was considered the optimum requirement.

The use of more manures and fertilizers was the most important factor connected with the Japanese method and the greatest emphasis had been placed on this. In Japan, very large quantities of manure mixtures are applied which consist partly of organic and partly of inorganic fertilizers; the latter, on an average, consist of 60 to 100 lbs. of nitrogen, 40 to 60 lbs. of phosphoric acid and 30 to 40 lbs. of potash per acre. In India, a limited quantity of organic matter was applied, and the comparatively new use of inorganic fertilizers was of a very limited nature. Experimental evidence in the country indicated that heavy doses of inorganic fertilizers, as practised in Japan, did not give economic returns in India. On an average, application of 20 to 60 lbs. of nitrogen per acre in the form of ammonium sulphate was found to be the

optimum in most of the areas, and a higher application resulted in a low yield response.

The practice of intercultivation not only removed the weeds, but also stirred the soil between plants to a few inches depth, which provided better aeration in the root zone to permit better assimilation of nutrients and promoting better tillering. In India, weeding is done once or twice during the season, but no interculturing is given. The number of interculturing varies from two to five, depending upon the duration of the variety grown.

By far the most important feature of the Japanese method of rice cultivation was the simultaneous application of all improved cultural practices, *i.e.* proper tillage, low-seed rate, row-sowing, adequate spacing, liberal and judicious use of manures, fertilizers and irrigation and weedings, etc. The Japanese method of rice cultivation was more beneficial in the areas of assured water supply, but it could also be safely practised, with necessary modifications, in the drilled rice tracts.

## THE FORD FOUNDATION TEAMS

During the First and the early part of the Second Plan, agricultural progress was reasonably good. In the 7 years following 1949-50, there was an increase of 18 percent in the irrigated area and of 15% in the gross cropped area, resulting in an increase of 22 percent in the agricultural production. Thereafter, however, the growth of agricultural production was checked, but there was steady increase in the rate of growth of population and the purchasing power with the consumers. The First Plan was based on a population growth rate of 20 million people in 5 years. In reality the rate of population growth was found to be much faster. It became evident by 1957 that the population was growing at a rate of about 2 percent per annum as against the anticipated increase of 1·3 percent per annum. Consequently, the foodgrains production target for Second Plan was raised from 76 million tonnes to 81 million tonnes. The actual production of foodgrains, however, recorded a fall during the year 1957-58 and the index for foodgrain production, with 1949-50 as base, declined from 120·8 in 1956-57 to 109·2 in 1957-58. Consequently, the imports of foodgrains had to be

stepped up from 0·5 million tonnes in 1955 to 3·7 million tonnes in 1957.

There was a wide-spread concern about the food situation in the country. The Government of India, therefore, invited a team of Agricultural Experts, of the Ford Foundation, to work in close cooperation with Indian Experts in making a careful study of the agricultural situation and to make proposals for a coordinated effort to increase food production on an emergency. The team visited India early in 1959 and its report entitled "India's Food Crisis and Steps to meet it" was published in April 1959. The proposals of the Ford Foundation were found useful and all subsequent programmes for increasing agricultural production in the country were formulated in the light of these proposals. The recommendations of the Ford Foundation Team are given in Appendix I. The recommendation regarding *selection of certain crops* and *certain areas* for more intensive efforts occupied a pivotal position amongst the various recommendations made by the Ford Foundation. Other recommendations were made only for re-inforcing its effect and optimising the ultimate results. The old G.M.F. approach implied dispersing of the available resources of inputs and technology over wide areas, paying equal attention to areas which were less productive and had far less potential for development and those areas which had high agricultural potential. This G.M.F. approach can also be described as the "extensive" approach because of the involved efforts for extending the operation of certain measures over larger and larger areas in the country. As against this, G.M.F. or "extensive" approach, the Ford Foundation Team recommended the adoption of the "intensive" approach under which the available resources were to be *concentrated* only in *certain selected areas* with high potentiality for growth. Because of this basic change in approach, the recommendations of the Ford Foundation Team can be considered as forming the water-shed in the evolution of the policy for increasing production of food-grains in the country.

## INTENSIVE AGRICULTURAL DISTRICT PROGRAMME

The Government of India had accepted, in general, the recommendations made in the "Food Crisis" report and had invited a second team of Ford Foundation to assist in planning the Intensive

Agricultural District Programme (I.A.D.P.) which came to be popularly known as the 'Package Programme". In November, 1959 this team made their recommendations in a report entitled "Suggestions for Ten point Programme to Increase Food Production". The ten points suggested by the team were :

1. Adequate farm credit, based on production-potential, made readily accessible through strengthened cooperatives.
2. Adequate supplies of fertilizers, pesticides improved seeds, improved farm implements and other essential production needs made readily accessible through strengthened service cooperatives.
3. Price incentives to participating cultivators through assured price agreements for rice, wheat and millets, announced two years in advance.
4. Marketing arrangements and services which enable the cultivator to obtain the full market price for his marketed surplus.
5. Intensive educational, technical and farm management assistance made available in every village in every development block in the district.
6. Participation of all interested cultivators, both large and small, in direct individual farm planning for increased food production.
7. Village planning for increased production, and village improvement to include livestock improvement programmes, strengthening of village organisation and village leadership.
8. A public works programme, using local labour to undertake drainage, bunding, soil conservation, minor irrigation. building of approach roads and other development works contributing directly to increase production.
9. Analysis and evaluation of the programme from its inception.
10. Coordination on a priority basis, by village, by block, district, State and Centre, of all resources essential to mount and carry out the programme with maximum speed and effectiveness.

Excepting the suggestion regarding price incentives at (3) above, all other suggestions were approved by the Government of India and in 1960, the Intensive Agricultural District Programme was

initiated in the country. The suggestion regarding public works programme, although accepted, was not implemented in direct connection with the IDAP.

The IADP Programme was also known as the Package Programme because of the package of improved practices recommended under it. The "Package of Improved Practices" evolved for each crop was intended to speed up the production process by presenting a suitable combination of known improvements based on the results of research which could immediately be applied to individual fields. The "Package" included the use of improved seeds, balanced ferilizers and manures, pesticides. improved implements and proper soil and water management.

"Package of Practices" were evolved for all the important crops and in many cases for different agro-climatic zones in each Package District. Specific recommendations were made regarding variety, seed-rate, time of sowing, etc. In many Package areas, seeds of the recommended improved variety treated with Agrosan GN were provided in sealed bags. Recommendations were also made regarding the total quantity of fertilizers, the doses and the time when these should be applied by a farmer. This was an important development in Indian agriculture in the sense that for the first time the available findings of agricultural research had been selected and summarised for application in the field. Thus, necessary link was forged between Research and Extension.

The Directors of Agriculture in the State Governments were asked to review the "Package of Practices" for the crops annualy so that the gaps in knowledge were brought to the notice of research workers and the package of recommendations improved upon from time to time. A few specimen 'Package of Practices' for the important crops grown in some of the Intensive Agricultural Districts are given in Appendix II.

The Extension Organisation of the Government of India was utilised for the preparation of farm plans for each individual farmer. In the initial stages, the State Governments evolved simple farm plans for adoption by the farmers. By the end of 1964-65, more than

a million farmers had been drawnin to the fold of the farm planning approach in the 16 Package Districts in the country.

The Intensive Agricultural District Programme was included in the Third Five Year Plan. The Plan stated :

> "In pursuance of this proposal, the intensive agricultural districts programme has been taken up, to begin with, in one district in each State. The Programme is intended to contribute both to rapid "increase in agricultural production" in selected areas and to "suggest new innovations and combinations" of practices which may be of value elsewhere".

The I.A.D.P. was, thus intended to be a "pace-setting" demonstrational programme to show how to increase production more rapidly and also a 'path-finding' progamme for developing new-innovations, new ideas and procedures for wider adoption in agricultural development.

To make the I.A.D.P. effective, the Third Plan went on to say that :

> "An attempt will be made to provide all the essential elements for increasing production to the extent needed...An effort will be made to provide credit on a scale sufficient to reach all farmers, including those previously considered uncredit-worthy, and credit and marketing will be linked".

It is important to observe that the I.A.D.P was intended to develop the farm community as a whole. The I.A.D.P. was to carry out a programme that speeded up agricultural production and, at the same time, carried the programme to all farmers, small as as well large, to tenants as well as to owners of agricultural lands. In short, the I.A.D.P. was intended to combine all efforts into one programme for the general economic development of the entire area in which it operated. It was not set up as a completely new or separate project or programme ; but, was built into the existing community development structure and organization.

The I.A.D.P. used a variety of approaches including those already being used in community development and added others such as working with individual farmer in developing farm plans. Efforts were made to reach all farmers through village institutions

like Cooperatives and Panchayats and formulate farm and village production plans with a view to involving all agricultural families, in due course of time. In the selected districts, attempts were made to saturate the entire cultivated area with use of improved varieties of seeds and the complete package of practices. This implied use of practices and improved implements as also the measures for soil and water conservation and plant protection. Under the I.A.D P. programme the total requirements of inputs were to be made available in time and at places within easy reach of the farmers. Efforts were also made to meet the credit requirements of the participating farmers.

The conditions laid down for the selection of the I.A.D.P. districts in the various States were as under :

(*i*) The district should, as far as possible, have assured water supply ;

(*ii*) It should have a minimum of natural hazards, *i e.* there should not be problems requiring long-term attention, such as susceptibility to floods, drainage problems, drought, acute soil-conservation problems etc. ;

(*iii*) It should, as far as possible, have well developed village institutions like cooperatives and panchayats;

(*iv*) It should have maximum potentialities for increasing agricultural production within a comparatively short period of time.

In 1959, seven districts were selected in seven States for the launching of the programme. The first four were selected mainly for rice, the next two for wheat and the last one for millets, as indicated in the table below :—

| | *District* | *State* | *Crop season* |
|---|---|---|---|
| 1. | West Godavari | Andhar Pradesh | Rabi 1960-61 |
| 2. | Shahabad | Bihar | Rabi 1960-61 |
| 3. | Raipur | Madhya Pradesh | Kharif 1961-62 |
| 4. | Thanjavur | Tamil Nadu | Kharif 1960-61 |
| 5. | Ludhiana | Punjab | Kharif 1961-62 |
| 6. | Aligarh | Uttar Pradesh | Kharif 1961-62 |
| 7. | Pali | Rajasthan | Kharif 1961-62 |

The programme was subsequently extended to other remaining

States also so as to cover at least one district in each State. The districts subsequently selected were :—

| *District* | *State* | *Crop season* |
|---|---|---|
| 1. Alleppey | Kerala | Kharif 1962-63 |
| 2. Palghat | Kerala | Kharif 1962-63 |
| 3. Bhandara | Maharashtra | Kharif 1963-64 |
| 4. Burdwan | West Bengal | Rabi 1962-63 |
| 5. Cacher | Assam | Rabi 1963-64 |
| 6. Mandya | Mysore | Kharif 1962-63 |
| 7. Sambalpur | Orissa | Kharif 1962-63 |
| 8. Surat | Gujarat | Kharif 1962-63 |
| 9. Bulsar | Gujarat | Kharif 1962-63 |
| 10. Jammu | J & K | Kharif 1963-64 |
| 11. Anantnag | J & K | Kharif 1963-64 |

The I.A D.P. concept was also used for implementing an area programme in Mysore State. In addition to Mandya district which was under I.A.D.P., the State brought parts of two revenue districts, Raichur and Bellary, under the Tungabhadra I.A.D.P. The Programme was also extended to the Union Territory of Delhi during 1964-65. After the formation of the new State of Haryana, I.A.D P. was started in Karnal district of that State from 1967-68. The Government of Rajasthan and Maharashtra, however, scaled down the I A.D.P. in Pali and Bhandara districts to the level of Intensive Agricultural Area Programme (I A.A.P.).

The I.A.D.P. districts were selected originally on the basis of the potential for increasing the production of the principal crop of the district. But, later on, the scope of the programme was enlarged so as to include all crops in addition to the one for which the district was selected.

At the time of the selection of the districts it was realised that the basic conditions laid down for their selection were rather difficult to meet. As a result, although the I A D P. was launched in some of the best districts in the country, the conditions for the programme could be only partially satisfied. The programme, thus, encountered various problems usually faced by the farmers. The

districts thus selected could, therefore, be useful in their role as the "path finder" but they could not play the role of "pace setters" also as they were originally intended to be.

One of the principal lessons stressed in the mid-term appraisal of the Third Five Year Plan was that much greater emphasis should be laid on the development of scientific and progressive agriculture in an intensive manner in areas where a high agricultural production potential existed. Accordingly, in January 1964, the Agricultural Production Board agreed that about 20 to 25 per cent of the cultivated area of the country should be selected for intensive agricultural development.

## INTENSIVE AGRICULTURAL AREA PROGRAMME

The Intensive Agricultural Area Programme was also based on the fact that the planning in agriculture, before the package programme concept was adopted, was defective and less productive because of the dispersal of limited resources of inputs and technology over too many schemes over too wide an area. Due to the limited availability of resources, however, the staffing pattern adopted in the I.A.A.P. was of somewhat lesser intensity and certain supporting facilities like soil-testing laboratories, implement workshops etc. could not be provided in these districts. This programme came into operation from March, 1964. The I.A.A.P. approach was not to be in terms of a single crop only, but rather in terms of an intensive agricultural development of the selected area. The number of blocks actually taken up for development under the I.A.A.P. are indicated below :—

| *Year* | *No. of Distts.* | *No. of blocks taken up* |
|---|---|---|
| 1964-65 | 114 | 1,084 |
| 1965-66 | 114 | 1,285 |
| 1966-67 | 114 | 1,410 |

## THE NEW STRATEGY

The New Strategy for Agricultural Development which was

adopted from 1966-67 was based on the experience of the old I.A.D.P. and one of the major planks of the strategy is the use newly evolved high yielding varieties of foodgrains. The evolution of these varieties and hybrids virtually started a new era for the agricultural production in the country. In the words of the Fourth Plan :

> "While both the Intensive Agricultural District and Intensive Agricultural Area Programme were concerned with the promotion of intensive agriculture, they operated within the limitation set by the existing crop varieties which had relatively low response to fertilizers. A major change occurred with the introduction of the high-yielding varieties. Hybridisation techniques for maize and millets had been initiated as early as 1967. Hybrid seeds began to be widely adopted by 1963. In wheat, a beginning of great importance was made in 1963-64 by trying out the mexican dwarf varieties on a selected basis Rice seeds of exotic varieties such as Taichung Native-1 were introduced in 1965. The propagation of various high yielding varieties over fairly large areas was taken up as a full-fledged programme from kharif 1966 onwards".

The New Strategy is concerned not only with higher yields per unit area, but with higher intensity of cropping also. Entirely new crop rotations had been made possible by the development of photo-insensitive, short-duration varieties of rice, wheat, maize, jowar and bajra, suited to different agro-climatic conditions. Among other crops, included in the rotations, are barley, pulses, ragi, oilseeds, potato and other vegetables. The new multiple-cropping programme was taken up from 1967 68.

A number of steps were taken to facilitate reorganisation and development of agricultural research because of the special importance of the agricultural technology in The New Strategy. The reorganisation of the Indian Council of Agricultural Research was started in 1965. An important step was the establishment of Agricultural Universities which are considered as capable of combining the functions of the education, research and extension work. Another important development was the initiation of all-India coordinated research projects. Thirty eight such projects were taken up by the I.C.A.R.

In view of the great importance of inputs and services in The New Strategy several new public institutions were promoted and provided with funds to facilitate their lending support to the agricultural production programmes. The National Seeds Corporation was set up in 1963 for the supply of quality seeds, particularly the foundation stock of high-yielding varieties. The National Co-operative Development Corporation was set up on a statutory basis in 1963, for promoting programmes for production, marketing, processing and storage of agricultural produce through cooperative societies. Also in 1963, the Agricultural Refinance Corporation was established to provide refinancing facilities to land development banks and commercial banks for financing schemes of agricultural development. Starting with 1965, fifteen Agro-industrial corporations were established in different States, as joint ventures of the Central and State Governments for the supply and servicing of agricultural machinery to the farmers.

The importance of guaranteed minimum prices as an incentive to agricultural production was given due recognition in the New Strategy. A policy of support prices for foodgrains came to be adopted throughout the country from 1964. The Agricultural Prices Commission was set up in 1965, to advise Government from time to time on appropriate price policies for agricultural commodities.

In order to ensure an effective implementation of its price policies, the Government of India also established in 1965 the Food Corporation of India which was to provide an all-India machinery for the purchase and storage of foodgrains in the country. The purchases were to be made both for facilitating supplies in times of shortages and for lending support to the prices in times of plenty. The F.C.I. remained quite ineffective during the drought years of 1965-67, because the prices remained at a level much higher than the support prices fixed by the Government, and, therefore, no purchases could be made. During the year 1967-68 purchase operations were undertaken by the F.C.I. in Punjab and Haryana following a bumper crop of wheat there.

## THE PROBLEM OF IMBALANCES

Within a few years of the implementation of the New Strategy it was realised that the selective approach of the New Strategy has vast potentialities for creating and accentuating imbalances in the economy. The farmers holding lands with assured irrigational facilities were already much better off as compared to the farmers who depended mainly upon rains for irrigating their lands. Now The New Strategy also sought to concentrate the available resources of inputs and technology over those very lands which had assured irrigational facilities and the unirrigated areas remained outside the scope of The New Strategy. In other words, it was the comparatively more favoured class of farmers only which was availing of the fruits of Government research and also received new seeds, fertilizers and credit facilities, while the farmers who were unfavourably situated in regard to their lands were denied any such facilities by the State. As a result, the gulf between the rich and the poor started increasing with the increasing scope of The New Strategy.

As a result of The New Strategy, a new 'rich' class of farmers has started forming in India, consisting of those who have proximity to markets, or ready access to fertilizers, or who have the resources, and choose to mechanise. A new entrepreneurial class is also expected to rise in the fertile field of agribusiness. But others have lagged behind. By creating pockets of unprecedented prosperity, amidst vast expanses of abject poverty and indignant indigence the new wonder seeds are, in fact, sowing the seeds of animosity and conflict which manifest themselves in the form of violent "incidents" here and there in the country — ostensibly on the ground of some dispute over the distribution of benefits of the new seeds. According to some, these are the convulsions of a society which is trying to compress into decades and years, what was achieved by other societies through steady progress, spread over centuries in the past.

With a view to helping the poorer sections of the farmers, the "programme for small farmers" and the 'programme for Dry land farming' were included in the Four

The main objectives of agricultural development mentioned in the Fourth Plan require special notice in this context. They are :

(*i*) to provide the conditions necessary for a sustained increase of about 5 per cent per annum over the next decade ; and

(*ii*) to enable as large a section of the rural population as possible, to participate in the development and share its benefits.

The priority programmes of development in agriculture, consequently, fell broadly into two categories, *viz.*

(*i*) programmes aimed at increasing production ; and

(*ii*) programmes aimed at remedying imbalances.

The 'programme for small farmers' and the 'programme for dry land agricultural development' come under category (*ii*) above and are not expected to make significant additions to the agricultural production in the country.

The New Strategy, thus, consists of the following :—

1. Cultivation of seeds of high-yielding varieties of crops ;
2. Incentive prices for the producers ;
3. Development of infra-structure consisting of credit, marketing, storage, research, education and training, power supply, transport and communication and administration ;
4. Development of irrigation facilities ;
5. Supply of all inputs *e g.* seeds, fertilisers, fungicides, insecticides etc etc ;
6. Plant protection and Post-control measures ;
7. Extension of multiple and relay cropping ;
8. Dry land farming ;
9. Small farmers' Development programme.

## CRITICISM OF THE NEW STRATEGY

The New Strategy aims at achieving "self-sufficiency" in food-grains by 1971. It may be possible to do so under favourable weather conditions. But this self-sufficiency achieved under favourable weather conditions will be rather spurious and deceptive. The real test of the "self-sufficiency" will be during the periods of com-

paratively less favourable or even unfavourable weather conditions. Dr. Ensminger, the Ford Foundation Expert, who has been closely associated with Indian Agriculture since 1952, is of the opinion that India still requires about 10 years for achieving self-sufficiency in foodgrains. According to him, there has been a definite break-through in wheat production, but, the rice production has lagged behind. The main arguments of Dr. Ensminger for advancing the date of self-sufficiency in foodgrains are as under :—

1. **It will take at least 5 years to evolve the high** yielding and disease-resistant varieties of rice, suited to different soils and climatic conditions.
2. Required amount of research has not yet been undertaken to ensure that the newly evolved high-yielding varieties of foodgrains can also withstand pests and diseases ;
3. Food self-sufficiency will remain a distant goal so long as the rainfed areas in the country are not provided with irrigational facilities ;
4. There is urgent need for modernising the marketing techniques and for building up efficient systems of service facilities.

That about 3/4th of the cropped area in India is dependent upon the unpredictable generosities of the wily Dame Weather, which can easily sway the scales for millions of tonnes on either side, renders almost futile the entire exercise for laying down any meaningful time-table for achieving self-sufficiency in foodgrains.

An important criticism of the New Strategy is that it tends to create and accentuate disparities in the incomes of the people. The area covered by the HYV varieties is only 10 per cent of the total cultivated land in the country. The farmers in the remaining 90 per cent land have not received the benefits of the cultivation of the HYV seeds. As a result, the rich amongst the farmers have tended to become richer and the poor have remained where they were. This tendency towards a widening of the gulf between the rich and the poor, if not checked well in time, may cause social discontentment on a large scale. Sowing of the new seeds may, thus, turn out to be the sowing of the seeds of discontentment in the country.

The programmes for small Farmers and Dry land areas which

have been incorporated into the New Strategy as the corrective measures are extremely inadequate and hardly touch the fringes of the problem. In addition to creating inter-regional imbalances, the New Strategy is likely to create local disparities also. Mechanisation is a natural consequence of the New Strategy. The affluent farmers are taking to harvesters and combined threshers with a view to ending their dependence on the manual labourers, the reduction in employment opportunities may, therefore, create in the countryside condition of acute poverty side by side with conditions of precedented prosperity. This will indeed be an explosive situation.

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# The New Seeds

The use of seeds of High-Yielding Varieties has been the kingpin of The New Strategy. The break-through in the yield rates has been possible only due to the use of newly evolved varieties of foodgrains under prescribed dosages of fertilizers plant protection measures and other agronomic practices.

The question of evolving improved varieties of foodgrains in India has been engaging the attention of the experts for the past several decades. The Royal Commission of Agriculture (1919) also dealt with the question of deterioration of soil fertility as a consequence of the removal of plant nutrients by the crops, year by year, without any replacement except through natural process of recuperation or general farm practices. The Commission tentatively concluded that an overwhelming proportion of the agricultural land of India had reached a condition of stabilisation of soil fertility long ago and that no further deterioration was likely to take place under existing conditions of cultivation. They justified the view that improved varieties of crops required, for their fullest development, more liberal manurial treatment than the ordinary varieties. The commission were of the view that a combination of water supply, manure, good cultivation, elimination of waste and efficient varieties of crops could lead to increasingly profitable crop production and isolated attempts at popularising improved varieties without making adequate provisions for other factors would not achieve the desired results.

All research activities for the improvement of seeds have so far been directed at achieving one or more of the following objectives :

1. Higher yields.
2. Resistance to pests and diseases.
3. Higher content of proteins and/or minerals.
4. Shorter duration of crops.
5. Adaptability to different ecological conditions.

Broadly speaking, early research in India had been directed largely to the achievement of objectives mentioned at 1 & 2 above. Recent research, however, is concentrated for achieving all these objectives simultaneously.

During the mid-sixtees, Indian plant breeder made remarkable contributions and augured an era of high crop yields such as were never reaped in the past. New varieties and hybrids, capable of giving phenomenally high yields were evolved for *wheat*, *rice*, *jowar*, *bajra* and *maize*. Cultivated over a large acreage in the country, under conditions of assured rainfall or irrigation and with appropriately high level of fertilisation and efficient pest and disease control, these new varieties and hybrids showed remarkable results.

The progress in regard to the work done for the evolution of improved varieties of seeds is given below separately for each foodgrain.

1. *Wheat*

Wheat breeding in India dates back to the early 1957, when pioneer work done under the leadership of the British Scientist Sir Albert Howard and Lady Howard resulted in the development of certain varieties like N.P. 4, N.P. 5, which yielded about 4000 kg. per hectare, under propitious conditions of weather and good management.

Greater attention was paid in later years to the development of varieties resistant to rusts, and varieties like NP 710, NP 718, NP 770, NP 798, and NP 809 became the mainstay of the farmer in years of severe rust epidemics. Work in the Punjab Department of Agriculture resulted in evolution of varieties like C 591, C 518, and C 281, which shifted the consumer's preference from red-grained to amber-grained wheat varieties. However, all these notable researches did not result in any significant increase in the per hectare yields.

In 1969, Dr. Swaminathan, Director, Indian Agricultural Research Institute (IARI) made a theoretical analysis of the factors responsible for the yield stagnation as well as instability in the production of the crop. His analysis showed that the very morphological architecture and developmental rythm of the tall Indian wheats precluded any striking improvement in yield rates since such improvement would occur only under good conditions of soil fertility under which these tall varieties of wheat lodged. Also, their long duration of growth and development (October—November to March April) exposed them to high temperature, coupled with soil as well as atmospheric drought, during the critical stages of grain development. The analysis logically concluded that the stagnant yield ceilings could be pierced only through introducing dwarf wheats which had a much less tendency for lodging and, due to their short duration, escaped the soil and atmosphere drought of the early summer months.

The dwarfing genes of wheat, which ultimately led to the evolution of the present high-yielding varieties of wheat, were found in Japan, where, probably, they had arrived from Korea. Commonly knowns as the "NORIN" dwarfs, these varieties were first brought to U.S.A., for the purpose of evolving winter wheat varieries. The U.S. Department of Agriculture, distributed the nurseries to various countries, for testing their resistance to rust. It was some of these nurseries that caught the attention of Dr. Swaminathan and his associates in the I.A.R.I. They got particularly interested in dwarf varieties of wheat which were developed in Mexico. The basic architecture of these plants was found to be very unusual. The plants were short with stiff erect leaves slightly more than knee-high, and put an unusually large number of tillers. These Mexican types also possessed great resistance to rusts and could take heavy quantities of fertilizers without lodging. The traditional Indian varieties of wheat, could be given only a small quantity of fertilizer, as larger quantities caused a good growth, and consequent tendency for lodging. Another important characteristic of the Mexican varieties of wheat is their non-sensitivity to photo-period. In other words, they could grow equally well in places where days are short or long. Many important crop varieties had failed earlier, when

taken from one country to another, because they were "Photo-Period-Sensitive" and could not tolerate the day-length difference.

The exotic varieties of wheat were first tested at seven locations during 1963-64 and at 155 locations during 1964-65, and also subjected to exhaustive physiological pathological, chemical and agronomic tests. Two dwarf varieties of wheat *viz.* "Sonara 64" and "Lerma Rojo" yielded approximately four times the average rate of yield in India. Towards the end of 1965, the Central Variety Release Committee approved and released these two varieties for general cultivation in India. The new agronomic practices necessary for enabling the dwarf strains to achieve the yield potential were standardised. Seeds of the dwarf wheats were multiplied in the Nilgiris during summer months. Over one hundred national demonstrations were organised by scientists in farmers' field to demonstrate the potentialities of the seeds and also the new techniques involved in their cultivation. The Government of India imported, 250 tonnes of seeds of "Sonara 54" and "Lerma Rojo", which were distributed to State Seed Farm and to over 5000 farmers. Trials with new drawf selections were laid out at 123 locations.

In the summer of 1966, the Government of India ordered 18,000 tons of "Lerma Rojo" and a few other varieties from Mexico. At that time this was the largest single seed order ever placed anywhere in the world. It was possible to plant 7 lakh acres of land with the imported 18,000 tons of seeds. For the 1967-68 crop, there was seed for 6·7 million acres, which meant almost 10-fold increase in one year in the area planted to the new dwarf varieties of wheat.

Besides, the "Lerma Rojo" and "Sonara 64" some other varieties of dwarf wheat were also evolved. There was cross in the first lot of the varieties of wheat, which the Rockfeller Foundation had supplied from Mexico in 1963. From this one cross (No. 8156) came a family of wheat varieties which to occupy the largest area in Asia. In India, it is called *Kalyans sona*" and in West Pakistan it is known as "*Mexipak* 65".

Three other important varieties of wheat have also come from the shipment that was received from Mexico in 1963. One is "*Sonalika*", 5308 which was later named yields as much as "*Kalyan sona*,"

has whiter and larger kernel, and matures earlier, thereby, helping the farmer raising more than one crop in a year. Second is S. 307 or "*Safed Lerma*", which is much like the original "*Lerma Rojo-64*", and has white kernels instead of red. The third, S. 331 or "*Chotti Lerma*", is an amber seeded variety suitable for Central and Southern India besides the major wheat areas of the North. This third variety also has the greatest resistance to all the three forms of rust *i.e.* stem-rust, leaf-rust and stripe or yellow-rust.

**Another variety, "Sharbati Sonora", is the most early of any of** the commercially important varieties. It was developed at the Indian Agricultural Research Institute by irradiating the original Mexican "Sonora 64" with Gamma rays. The resultant mutant is bold and amber in colour, whereas its original colour was red.

Indian scientists are now working on "Triticale", a cross between Durum wheat (Triticum) and Rye (Secale). This is the first man-made specie of grain with large commercial potential. Triticale is something wholly new and man-made which was first achieved in Sweden many years ago, and, on which, further research was made in Spain. Originally, Triticale was found to be highly infertile. It would make large heads, but, there would be few or no kernels. This problem seems to have been overcome by the scientists. Now the grain is rough, but of poor milling quality. These are the characteristics inherited from its rye parents and intensive research is being done for bringing about improvements in this regard and for evolving varieties suitable for growth in India.

Eventually, the yield of Triticale may exceed the yield of wheat. The grain contains more protein *i.e.* sometimes 18 to 20 per cent, compared with 10 to 16 per cent in wheat. Moreover, the Triticale protein contains more of the amino acid called lysine, which is an essential ingredient of good nutrition for human beings and animals. While the grain lacks the gluten to make good bread-flour, it may very well make excellent "*Chapaties*" which is the mainstay of diet in North India.

An important characteristic of Triticale is that it can withstand dry weather, and, precisely for this reason, it might prove a boon to

some of the semi-arid areas of India. Within 2-3 years, improved varieties of Triticale might be ready for release as an excellent live-stock food, which may, probably, be its first major use. Some time later, Triticale may also become an important human food.

Another line of wheat research, important for the limited rain-fall regions of the country, is the one concerned with the "Branched" varieties of wheat. Some of the research work in this regard is being done in India; but, a more extensive programme is under way in Mexico. These varieties of wheat have rudimentary tillers and only one main stem — which is about all that can be supported by the limited supply of moisture. The stem bears a head that is flat and broad, instead of being long and slim, as in the case of other varieties of wheat. This "branched" head sometimes contains half again as many kernels as the ordinary heads. In the branched variety, the yield per plant is less than that for ordinary varieties of wheat in moisture-rich areas. But, it has good scope for improvement. According to scientists, the prospects are good to warrant further research on the branched varieties of wheat, although, they are far behind "Kalyan Sona" in so far as yields are concerned.

Valuable research is being done in India for raising the protein content of wheat. It can be done in two ways: by breeding and by putting on enough nitrogenous fertilizer. Just putting enough nitrogen in the soil via fertilizer is the quickest and easiest way of increasing the protein content of wheat. The plant can be relied upon to do the job if it has the required ingredients made available to it By using both approaches *i.e.* breeding and fertilisation, the scientists have been able to achieve an appreciable increase in the protein content from the 9-10 percent, which has been standard in most varieties of wheat in India, to 16-17 percent which is about the highest in the world.

Many Mexican and Indian varieties of wheat combine very well, and Indian scientists have already made more than 5,000 crosses between them. India's wheat research programme should be expected to bring about further improvements in the yield rates and the nutritive value of wheat in India. Fortunately, the new dwarf varieties that yield more, are also found to be rich in protein and the essential amino acid, lysine. A special laboratory has been estab-

lished at the Indian Agricultural Research Institute to find out as to which of the new varieties of wheat are superior in quantity and quality of protein. This laboratory works in close collaboration with the much advanced similar laboratories in Mexico.

The "Three-gene dwarfs" or "Triple dwarfs" are the subject of another very important research project in wheat. Some of the new varieties of wheat have one dwarfing gene in their chromosome make-up, some have two and now some have three. The more the number of genes in the plant, the shorter it becomes. Even the two-gene dwarfs like "Kalyan Sona", sometimes fall over, just before the harvest. When plants fall flat over the ground due to winds and storms, they are readily consumed and destroyed by rats. For a farmer, this can be an unbearable loss and, therefore, the "Three Genes" are becoming increasingly popular, and some of the three-gene varieties are likely to be the wheat-varieties of future. There is a particularly promising cross in Mexico, known as No. 23584. It has performed unusually well in Mexico, India, and West Pakistan. In Mexico, it has yielded about twice of what an average good yield would be for the U.S.A. spring wheat.

The resulting new selections from India's extensive breeding programme are used not only within the country, but, are also sent back for trial in Mexico. Thus, there is now a two-way exchange; and, in some cases, the Indian scientists return better material than they receive in the first instance.

There is, however, one serious deficiency in the wheat research programme. Presently, only one dominant family of wheats (derived from cross No. 8156) is sown throughout Southern Asia. All the varieties of wheat in this family have the same kind of rust resistance. If, therefore, a new race of rust, to which these varieties may be susceptible, were suddenly to appear, much of the wheat crop of the vast stretch of the world would be devastated almost overnight. One of the top priorities for the Indian scientists, therefore, is to bring out varieties with genetically different kinds of resistance, in order to safeguard against the possibility of the country losing its entire wheat crop to some new race of rust, against which the present

varieties of wheat may not have any resistance. Research is being done in this regard and The Ford Foundation and The Rockefeller Foundation have sent one expert each for assisting Indian scientists in finding out a solution to this menacing problem.

India has got at least four wheats with somewhat different kinds of rust resistance — Kalyan sona, Sonalika, Safed Lerma, and, most resistant of all, Chhoti Lerma. But these do not offer enough insurance, and the scientists are working hard for still better ones. Certain hilly areas, where it is possible to raise a second crop of wheat the same year, because of a later season, have been attached with the university experiment stations down in the plains, for facilitating research works for rust resistance. In the process of the research, thousands of plants are inocculated with all the known races of rust, and only those plants that survive are retained for further breeding works. Others are discarded, whatever their other qualities may be.

For the rabi crop of 1970, the Punjab Agricultural University released three new varieties of wheat *viz.*, WL 212, WG 377 and WG 357. The first of these three varieties *i.e.* WL 212, is a triple dwarf variety, which does not lodge even under very high fertility conditions. WG 377 is a two-gene dwarf variety which gives good performance under various agronomic conditions. WG 357 is a quality wheat seed which combines high yield with excellent grain properties.

The extensive trials conducted during the last few years under the All-India Coordinated Wheat Improvement Project have indicated that some recently produced Indian wheats and also certain Mexican semi-dwarf wheats, do better under rainfed conditions than the earlier released varieties and yield 10-15% more on an average.

The Mexican semi-dwarf wheat selection Kalyan sona and the Indian varieties Pb. C. 306, HD 1460 and K 65, showed the widest adoption in the main wheat zones. K 65, one of the wheats with excellent grain quality is grown on large areas in rainfed and medium fertility fields of U.P. NI 747-19 and NI-5439 have done well in peninsular India. Hyb.65-13 (HD 1467) is particularly suitable for cultivation in the Central, Peninsular and Eastern zones. All these wheat

varieties are early to medium in maturity and have amber hard grain which are very much liked by the farmers and consumers.

## 2. Rice

As compared to wheat, the dwarf rice research programme is comparatively new in India and it started in the year 1965-66. During 1967, the new high yielding varieties of rice introduced in India, could be tried on a national basis. As compared to wheat, the research programme in rice is confronted with a larger number of problems. Farming operations in about 4/5th of the cropped area under rice are performed during the cloudy monsoon season when light is a limiting factor. Wheat, on the other hand, is grown during the bright sunny season. Rice is also a more difficult crop to grow and needs more water, more work, more struggle against the insects, and also a lot of skill on the part of the farmer.

T.N.I., the well-known improved variety of rice, was developed in Taiwan by the crossing of a tall, drought-resistant variety with another variety called "Dee-geo-woo-gen". (literally meaning brown tipped, short-legged). In India the I.R.R.I. scientists used T.N. I and its parent, Dee-geo-woo-gen, in crosses with the tropical *Indica* varieties of rice. During *Rabi* season of 1964-65, T.N. I was grown at a few of the Indian experiment stations and it yielded 9,000 kgms of paddy per hectare, as compared with India's per hectare average yield of about 1,000 kgms. During the year 1965, when the monsoon had failed, the small acreage of T.N. I gave impressive yields.

During June 1965, a ton of T.N.I. was received from The Rockefellers by air, and in October 1965, five tons more came by ship from Taiwan. In the year 1966, Taiwan donated eighty tons of T.N. I to the National Tonnage Club. a farmers' organisation in India. During the *rabi* season of 1965-66, National Seed Corporation and the Orissa State Government, together multiplied the seed on about 6,000 hectares. A total of 20,000 tons was harvested in 1966, and some of the seed was sent to every state of the Indian Union. In this way, area under T.N. I rose from a mere 60 hectares to 600 thousand hectares during a single growing season *i.e.* 1965-66.

T.N.I. has proved to be a valuable breeding material in India, and has been used in many economic crosses. "Jaya" is a product from an important cross of T.N.I. and is better than IR-8 in yield and earliness. "Jaya" derived its dwarf characteristics from T.N.I. and the adaptability from T-141, atall Indian variety from Orissa. In this way, India and Taiwan have contributed equally towards the making of "Jaya" which is, so far, India's top yielding variety of rice.

The parents of IR-8, another important high yielding variety of rice, were little "Dee-geo-woo-gen" and a tall variety from Indonesia called "Peta", which had in its parentage, a West Bengal variety "Latisal", famous for its vigour. It was tried in India in 1966 and yielded better than any other rice variety including T.N.I. and The Ford Foundation sent, by air, 10 tons of seed and The Rockefeller Foundation brought in another 10 tons by ship. By 1970, the area planted to IR-8 in India increased to about 4 million hectares.

The most important contribution, over time, of both IR-8 and T.N.I. will be their plant type and the plant architecture. Every new variety, presently grown in India and elsewhere in Asia, is based on their pattern of dwarfness, good tillering ability and erect leaves and photo-insensitivity. Most probably, this will hold true for all the high-yielding varieties of the future also.

Both "IR-8" and "Jaya" varieties of rice have very high yield-rates ; but, their kernels are coarse, have a "white belly", and both crack badly in hulling and milling. The Indian breeders are, therefore, trying to evolve some fine varieties, with kernels, which are long, slender and clear. "Padma" is a new variety that yields about 10 percent less than T.N. I, but is of finer quality. "Hansa", another new variety, yields about the same as "Padma" and is still finer. There are, however, several other selections like Sabarmati and Jamuna, in the trial plots, which look even better than any of these two.

In the deltas and low-land areas, along large rivers, there are native varieties which are called "floating rices", that grow 12 to 15 feet tall under flood conditions. Certain varieties of rice are designed to tolerate the cool climates of the hills in the north, and

certain others are adapted to upland culture where farmers sow on dry lands and then hope for rain. "Annapurna" is a new dwarf red variety of rice which is grown in Kerala. Certain other varieties with purple leaves are grown in several states. The purple characteristic is valuable, because it helps the farmer in rogning and weeding out the "volunteer" or wild varieties of rice.

With the advent of new varieties and use of balanced fertilizer, the leaf-hoppers and plant hoppers become a much more serious problem than before. The dwarf rices have thick, luxuriant stands, and shading prevents the dews and rains and paddy-water from ready evaporation. This lush growth and humidity, coupled with high temperature, becomes ideal breeding ground for the hoppers. Even a slight infestation of hoppers, reduces yields to some extent, and a heavy one produces "hopper burnt" and nearly ruins a crop. Moreover, the hoppers carry various diseases, from one plant to another. After long and careful experiments, carried out in the IRRI, it was found that "IR-8" is particularly immune to the green leaf-hopper. But "IR-8" was, however, not found to be immune to the brown plant-hopper. On the other hand, "Mudgo", a tall scraggly and rather worthless variety of rice was found to be resistant to the brown hopper, but vulnerable to the green-hopper. Now the plant breeders at IRRI are crossing "IR-8" with 'Mudgo' and hope to come up with a rice that will resist both hoppers and, at the same time, give high yields. Its grain quality will be poor at first, but that can be improved later, through further crossing with finer varieties.

Gall midge also takes a heavy toll of the Indian rice crop in areas where it is endemic. In all likelihood, a good new variety with midge resistance, high yields, and superior grain quality may be soon ready for release.

Plant diseases, though not as damaging to rice, as attacks by insects, nevertheless, cause significant losses—particularly, the diseases known as "leaf-blight" and "blast". Here, too, the best hope is to find out rices that possess built-in resistance. There are enough variations which can give the plant pathologists, something worthwhile to hunt for. Some 1,000 to 1,500 selections are screened every year for blast resistance at 13 main locations in India, and testing

for leaf-blight is done at five stations. When the breeders find that certain selections are resistant to one insect or disease and that others are resistant to another, they cross these two. Only the successful combinations, that include good resistance to both, are retained for further research.

Varieties such as "IR-8" and "Jaya" have the potentiality to yield 10 tons per hectare, and on most of the rice areas of India, they can give at least 6 or 8 tons. But the great majority of Indian farmers are still getting only 1 to 1·5 tons per hectare. This is largely attributable to the want of sufficient farmer know-how in the handling of these new varieties. For example, precision in a small detail like depth of planting in the case of wheat, can make a 25 percent difference in yields. It shows the importance of the farmers knowing correct agronomic practices. Another need of farmers is varieties better suited to the cloudy, rainy weather of the monsoon season. Rice, like any plant, needs sunlight. Jaya does reasonably well in cloudy weather — thanks to its Indian parent T.141, which is one of the most efficient user of sunlight known so far. But, there is still much to be done for developing superior varieties of rice for monsoon season.

### 3. Maize

Maize is believed to have been introduced into India by the Portuguese during the sixteenth century. In Sikkim, still there is a white variety known as Sikkim Primitive-1, which closely resembles the corn excavated in southern Maxico, that has been dated around 3500 B.C. The Sikkim germplasm has been useful in the breeding programme for maize, especially in the attempts to produce "prolifics" varieties that bear more than one ear per stalk. Sikkim Primitive-1 has four to six nubbin-like ears per plant and is being crossed with Georgia "cow-corn" from the United States which is a tall, white dent variety, having about three small ears per stalk.

Systematic Research for evolving better varieties of maize started in India after the Bengal famine of 1943. In 1945, the ICAR launched a breeding programme in the Punjab, which produced one hybrid, that, at times, produced 15 or 20 percent more than the local varieties. Breeders in Rajasthan, Andhra Pradesh and Mysore, also brought out new varieties and hybrids which showed some

improvement. But, for various reasons, these varieties never got popular. Hybrid maize was, however, proving extremely successful in the U.S.A. and attempts were, therefore, made to introduce it from the U.S.A. to India. A research programme was started by the Punjab and Uttar Pradesh governments in cooperation with the U.S A.I.D., to produce U S. hybrids from imported material. The Indian Agricultural Research Institute also imported about 50 hybrids from the U.S.A. and Australia, which, when tested locally, yielded about 80 to 120 percent more than the varieties developed in India. But hybrids need a seed industry that can maintain the purity of the in-bred lines from which the hybrids come. And, India had no such industry. Moreover, most of the imported hybrids were dent type, whereas preference in India was for the flint type, with smooth, hard kernels.

Again, in 1954, the Indian government invited two maize specialists from The Rockefeller Foundation in U.S.A , to assess the possibilities for improving production of this crop in India. The two experts found that India had varieties of only limited genetic variability which were inadequate for a countrywide programme. The experts also pointed out that the Indian varieties could not respond adequately to fertilizer; had poor husk cover; and were highly susceptible to downy-mildew, leaf blights, rust, and stalk rots. as also to attack by stem-borers. The inbred lines from the United States used as parents of the hybrids could also do well only in the cool climate of the northern regions and were not suitable for the hot wheather conditions in southern India. The experts, therefore, suggested bringing germplasms from other tropical and sub-tropical areas like Mexico, Central America, the Caribbean region and the southern United States and recommended establishment of four main research stations and nine sub-stations to cover the wide range of conditions obtaining in the different maize-growing areas of the country. An important suggestion made by the experts was in regard to the formulation of an All-India Coordinated Maize Improvment Programme. The I.C.A.R. accepted the idea, which ultimately proved a great success. Regular annual meetings were held, at which all experimental work of consequence, done anywhere in India, was reported and the programme for the following year outlined. The Indian Agricultural Research Institute in New Delhi, which was also

one of the four principal maize research Stations, was designated the coordinating centre for the entire programme. The Rockefeller Foundation provided a joint coordinator for the programme in the person of Dr. U. J. Grant and, later on, Dr. Earnest W. Sprague.

The Indian plant breeders crossed, in all possible combinations, the breeding materials received from the tropical and sub-tropical regions and then tested 18 sets of 45 combinations and ultimately arrived at four varieties, of which two *viz.* "Deccan" and "Ganga 101 are among the country's leading varieties of hybrid maize.

The first double-cross seeds of maize were ready by 1961. On being tried, they yielded about four times the normal yields and were found to be highly responsive to fertilizers. After 1962, a more elaboerat research programme was undertaken.

From 1960 onwards, the plant breeders in India have produced 10 successful new hybrids, designed to meet the varying needs of the major maize-growing areas in the country.

A well-developed, closely supervised, and sophisticated seed industry is, however, a must for the hybrid seeds. In the first place, the parental inbred lines must be maintained absolutely pure, which is a job for the experts only. Secondly, hybrids must be grown from new seeds every year, and, for that reason, expert's attention becomes absolutely necessary.

The plant breeders have also given attention to the development of composite or synthetic varieties, which are created by planting a number of promising lines, in close proximity to one another, so as to facilitate cross-fertilisation through the medium of winds only. At least a few of the resultant composites turn out to be exceptionally good, if the plant breeders choose wisely, and if enough genetic diversity is involved. The advantages of this method are that the same seed can be used, year after year, without much deterioration, and that farmers can save their own seed for four or five successive years without buying new stocks.

During the recent years, six superior composites have been developed in India, suiting the various regions of the country. All of them yield almost as much as the hybrids, and, one, called

"Ambar", is reported to yield even better. "Vijay", another composite is also considered very promising.

Research in maize has three important objectives :

(*i*) evolving a short duration type that can utilize large quantities of fertilizers without lodging;

(*ii*) evolving a plant with erect upper leaves which may let in more sunlight; and

(*iii*) increasing protein content of the grain.

Good progress has been made in regard to the first two of these objectives, although no dwarf erect-leaf varieties are yet ready for release. Similar work at the University of Illinois has, however, shown good progress. In regard to improving protein content of the grain, the scientists at Purdue University in U.S.A , have isolated two genes, opaque-2 and floury-2, which increase lysine content substantially. The breeders in India are duplicating their results and hope to achieve before long, a high-lysine variety that will combine high nutritive value with good yield rates.

Maize in India is found to be susceptible to attacks from about half a dozen different stalk rots. The best remedy for the stalk rots are agronomic measures *viz* good drainage and ample fertilizer containing enough potassium. For the downy-mildew, the only approach appears to lie in evolving resistant varieties. Fortunately, certain crosses offer the best source of resistance to the new downy-mildew found in India. Certain crosses from the Philippines show tolerance to the other mildews.

An interesting project under India's maize research programme relates to the development of 'pop-corn" and the breeding of "prolifics" which bear two or more ears per stalk. Still another project of interest is that of producing a variety that can be harvested in northern India from February to May and, thus, facilitating growing of three successive crops in a year, instead of the present two.

The Uttar Pradesh Agricultural University, one of the four main centres in the all-India maize programme, also serves as the regional headquarters for the Inter-Asian programmes activities in Pakistan, Nepal and Afghanistan. Bangkok services the more southerly, low-lying countries of Thailand, Vietnam, Malaysia, Ceylon,

Indonesia, and the Philippines. The only countries of the area, not yet participating in the maize research programme, are Burma, Cambodia and Laos.

**4. Jowar**

*Jowar* ranks third in acreage among the world's grain crops, and, originally, it is said to have come from Africa. India is the largest producer of *Jowar*, and, together with Africa, accounts for 85 percent of the Jowar grown in the world. In India, *Jowar* is the third most important cereal crop after rice and wheat, and is grown all over the country, except in the four eastern states of Bihar, Assam West Bengal, and Orissa *Jowar* requires comparatively smaller quantity of water and only 1·5 percent of India's acreage under *Jowar* is irrigated.

India has become virtually the centre of research for *Jowar* and has built up world's largest *Jowar* germplasm bank, which receives materials from almost all the *Jowar* growing countries of the world. Presently, India supplies nurseries to eighteen *Jowar* producing countries of the world.

The Indian scientists have been working for improving the yields of *Jowar* for the last sixty years or so. In spite of the various handicaps, they succeeded in developing some good varieties such as M 35-1 in Maharashtra, a whole series of "CO" varieties at the Coimbatore College of Agriculture and Research Institute, and certain lines from the Karnatic hills of northern Mysore and southern Maharashtra.

The lack of genetic diversity in Indian varieties of *jowar*. was a serious limiting factor for the furtherance of research work in India. Indian varieties were not responsive to high doses of fertilisers and per acre application of 30 pounds of Nitrogen or so was considered to be the practicable limit. Consequently, yields stagnated at a low level. Moreover, many scientists were of the view that several varieties of *jowar* were suitable to local conditions only. This view inhibited exchange of materials even between different areas within the country.

The research programme in *Jowar* received a big boost in 1957,

when a Rockefeller expert brought to India, about 800 selections, which formed the nucleus for the present world collection. By 1960, India's collection of germplasm rose to some 4,000 selections, representing more than 1,000 lines.

In 1964, India's first *jowar* hybrid, CSH-1, was released for the 1965 sowing season. The drought conditions during that period only established the efficacy of the newly evolved hybrid *jowar* seeds. In exceptional cases, CSH-1 gave yields as high as 2,000 pounds an acre, at the height of the drought, which was four to five times the average for the country in normal years. This resulted in a big demand for the seeds. Prices for seeds, therefore, increased to about 35 to 40 times the price of *jowar* in the market. Another hybrid, CSH-2 was also released in the year 1965.

After two hybrids having been made available, research was directed towards finding an equally good variety which would involve no hybridization and, thus, save the farmers much botheration and extra expenditure in buying their supplies of seeds every year from seedsmen.

In 1968, a variety named "Swarna" was evolved which yielded almost as well as either of the two hybrids, except in the drought years, when its performance is sometimes inferior to theirs. It had the additional quality of having the erect upper leaves which facilitate sunlight reaching the bottom leaves.

While "CSH-1", "CSH-2", and "Swarna" mark a great advance, they are susceptible to the ravages of the shootfly, which is *jowar's* greatest enemy in India, and to attacks by the stem-borer and midge. These varieties also lacked resistance to the several other common diseases of *jowar*. Research is still under way for evolving suitable varieties which are not susceptible to the above mentioned pests and diseases.

Yields of *jowar* can be raised substantially through use of improved varieties and fertilizers. The average yield of *jowar* in India stagnated around 500 pounds an acre, or less, for several years. Assuming 25 or 30 inches of rainfall a year, use of a high-yielding varieties, and good methods of cultivation, including insecticides, a

farmer can now easily get around double of this yield, just by putting in 50 pounds of nitrogen per acre.

Jowar fits specially well into a multiple-cropping system. It can be used in rotation with rice or wheat, or with pulses, vegetables, soybeans or maize. There is a good scope for a larger and larger proportion of farmers taking to multiple-cropping, with more and more short season varieties being evolved by the scientists.

**5. Millets** (*Bajra and ragi*)

India is the largest producer of millets in the world, and, together with China and Africa, accounts for about whole of the world production.

Millets, though considered "coarse grain" make an extremely nourishing food. Studies made in India show that some of the better millet strains are even superior to wheat, corn and rice, if account is taken of the fats and minerals, especially calcium and iron, present in these grains. Pearl millet contains as much protein as the more popular cereal grains. Some 60 million people in India who depend on millets for most of their food, appear to be as healthy as the rice and wheat eating population of the country.

During the period 1959 to 1962, some 3200 indigenous varieties of millet were collected, to which were added another lot of 2850 and also a good number from the F.A.O., making thereby, a huge collection of about 10,400 lines in all. This whole collection is now being evaluated and classified. It is maintained in cold storage at the Indian Agricultural Research Institute, where it is being kept viable through replanting every four or five years.

Long and valuable research outside India had led to the evolution of 'Tift 23A" which was brought to India during 1961 and was crossed with the best available varieties. A combination of the "Tift 23A" with another line called "BIL 3B" yielded hybrid with outstanding performance. After extensive trials, it was released in February 1965, under the name Hybrid Bajra. 1 (HB-1).

HB-1 thus became not only the first approved pearl millet hybrid in India, but, also the first to be grown commercially anywhere

in the world. The multiplication of the seed was entrusted to eight seed growers and, thus, enough seed was available for planting 4,000 acres in 1966.

A series of demonstrations showed that "HB-1" had several advantages in addition to its high productivity. It produced a more uniform stand ; its grain was of the accepted slate or steely-blue colour ; the foliage was leafy and stayed green after harvest ; it tillered profusely; and the stems were succulent and also somewhat sweet (a charecteristic that added to their value as a livestock feed). Morcover, HB-1 was resistant to downy mildew or green-ear disease (which is a major problem with pearl millets in India) and also seemed relatively immune to attacks by most insects.

After the release of HB-1, three more hybrids were released, *viz.* HB-2, HB-3 and HB-4. HB-3 has grain that is 20 percent more "bold", and HB-4 ratoons faster (—puts out a second crop more quickly from the same roots after the first crop is harvested). These two have the potentialities of becoming the dominant varieties in India—HB-3 for western India and HB-4 elsewhere.

More recently, two important events, have taken place The first is that there has been found an additional source of male sterility, thereby, giving genetic variability to their breeding materials and opening new vistas for nearly unlimited progress in pearl millet breeding. The second is the development of dwarf hybrids.

Some dwarf materials have been received from Georgia and the breeders at the Indian Agricultural Research Institute have been combining these dwarfs and the dwarfs found in India, with the existing four hybrids. Some of the resulting crosses have big heads on stalks and are about knee high. Further research in this direction can result in a dramatic breakthrough in so far as millets are concerned.

Two of the significant problems with pearl millet, that still await solution, concern the losses caused by birds and the increasing incidence of the diseases in some areas.

*Ragi* is the mainstay of diet not only for the poor, but, also for some 'of the well-to-do in the three states of Mysore, Andhra

Pradesh and Tamil-Nadu, as well as in scattered spots elsewhere, including the Himalayas, where it is known as Mandua. In fact, it is so highly thought of, that, on occasions, it brings twice as high a price as wheat.

*Ragi* produces seeds on five to seven or more "fingers" which comprise the head and it is, therefore, called finger millet. The grain is very small, not much bigger than the birdseed. It is grinded into flour from which are made a sort of cake, a porridge, and dough balls. Finger millet is also used in malting. The seed is usually reddish brown but also varies from purple to white. It is highly rated as a food by people who do heavy manual work, because it seems unusually sustaining. It is also considered an excellent food for expectant mothers, because of its high calcium content. Although it is relatively deficient in protein, some of the newer varieties have tested up to 11 percent—the level of some of the pearl millets. This indicates that there are excellent opportunities for improving the nutritive value of the crop through breeding.

Grain yields of ragi average 800 pounds per acre *i.e.* double the average for pearl-millet, and under exceptional circumstances, with use of an improved variety, yields of up to 7,000 pounds have been recorded.

Research work on finger millet (ragi) was started in 1963, with an evaluation of nearly 900 stocks of this species contained in the germplasm bank in New Delhi. A series of uniform yield trials, at various experiment stations, yielded about half a dozen superior strains.

Thus for, *ragi* appears to have relatively few insect problems. Also, the birds damage it less than they do pearl-millet.

Although finger millet is a crop for dry lands, it is often transplanted and raised under irrigation, where it works well in a multiple cropping system.

Like the other millets, finger millet has possibilities that have never been fully realized, and some of these depend on research in agronomy, pathology and entomology as well as in plant-breeding. Back in 1965, Dr. Rachie estimated that if the same good farming

practices employed in the uniform-trial plots had been extended to all the 5·5 million acres of finger millet in India, the total production that year would have been three and a half times of what it was, and another 20 per cent higher if farmers had planted one of the two highest-yielding strains. Good farming methods and improved varieties are the two important factors for ragi cultivation.

The Indian Council of Agricultural Research, in its annual report of 1965, noted that "*ragi* has received only limited attention. Although several improved strains have been released in Mysore, Madras, Andhra Pradesh, Bihar and U.P, there has been no serious attempt to test the adaptability of these varieties on an all-India basis." India's Fourth Five Year Plan also recognises the need for a vigorous programme for the drier parts of the country.

As reported above, the millets have some unique merits as dryland crops. They are resistant to drought, they tolerate extreme heat, they produce a crop even on poor soils, they have relatively few insect pests, and they are nutritious both for man and for his animals.

In the long run, while total millet acreage may decrease, total millet grain production will undoubtedly increase, and the grain will be used more and more for India's growing livestock and poultry industries.

Serious efforts are being made to promote millets not only on a national but also on an international scale and there are plans for the establishment of an international centre of millets in India, as well as one for *Jowar*. It thus appears that these, so far neglected crops, are well on their way to join the family of major cereal crops as full-fledged members.

## PULSES

In addition to the cereals, pulses constitute perhaps the most widely used component of the Indian diet. While occupying a large part of the area under foodgrains, their relative contribution to food-grain production is low. The production statistics for the crop year 1968 69 show that pulses constituted only 11% of the total food-grains production in the country, while they occupied nearly 18% of

the area under foodgrains. There has been no significant increase in the production of pulses during the last 20 years. The production has fluctuated as a function of changes in the seasonal conditions, particularly the rainfall.

The lower production of pulses, compared to the cereals, can be attributed to their poorer yields per unit area. The national average per acre yield of pulses, compared to the cereals, has been, in general, less than half, and this difference has widened greatly in recent years, following the advent of the high-yielding varieties of cereals. The non-availability of short duration varieties is partly responsible for the fact that, in many cases, the cultivation of cereals and pulses overlaps. As a result, the farmer has to choose between the two crops. He does not find it possible to grow cereals in rotation with pulses in multiple cropping pattern. Another factor which is respon ible for poorer yields of pulses is that these crops are generally grown under low moisture and fertiliser conditions and the general level of management practised in their case is not as satisfactory as in the case of cereals. The result is that varieties have not been developed in the past which can take advantage of more favourable conditions, such as fertilisers and other inputs.

The most important characteristics of the new varieties which have been developed as a result of research in the I.A.R.I. is their shorter period of maturity and relatively higher yield rate. The most significant outcome of this work, from a practical point of view, is that (i) pulses can now be fitted into a series of multiple cropping patterns in rotation with cereals, so that two groups of crops complement each other, rather than compete with each other, for land and other inputs etc. (ii) pulses can replace some of the other crops like maize, whose cultivation on a very large-scale, may no longer be considered desirable.

In spite of the low yields, pulse crops are still, and will in future, remain popular with the Indian farmers, mainly because this group of crops is capable of giving some return with little cultivation and lesser input as also under moisture stress. This group of crops also possesses deep root system which enable it to tap large volume of sub-soil water, and, in this process, opens up the soil upto deeper

layers. Pulses are also self-supporting to some extent in regard to their requirement of nitrogen, because of their ability to fix atmospheric nitrogen. These are some of the reasons why pulses have been popular with the farmers through centuries and have been recognised as restorer of soil fertility.

**Arhar** (*or tur*)

At present arhar occupies about 2·5 million hectares of cultivated land in India. Not all of this acreage is responsive to the application of package of modern practices. However, nearly one million hectares of land under Arhar can be rated as good land on which an average yield of 2 tonnes per hectare can be reasonably obtained with a package of practices. It is also being increasingly felt that farmers are no longer very enthusiastic in continuing the recommended programme of maize cultivation because of its high cost of production and low prices. Hence, it is likely that some percentage of maize acreage may now be profitably diverted to arhar in a rotation like arhar-wheat, because of evolution of short duration early maturing (nearly 130 days) variety like AS3 and AS5 of IARI and Type 21 of Uttar Pradesh. Among the late maturing varieties, the wilt-resistant Types 17 and T7 of Uttar Pradesh are still very popular for single-cropped rainfed areas, or for mixed cropping with *Jowar*. Other promising varieties are NP (WR) 15, R7, S29, S103, NP 69 and R98.

**Green Gram** (*Moong*)

At present, moong is grown on about 2 million hectares in India. As in the case of *arhar*, only about 50% of this area is good land and will respond favourably to the application of inputs. It is also considered feasible that, of the 5 million hectares of irrigated area of wheat, at least 2 million hectares can be brought under summer moong which can be grown as an additional crop. The early maturing moong varieties released from Uttar Pradesh Department of Agriculture, are Type 2 (shining moon) and Type 44 and T 51. Pusa Baisakhi has been isolated in IARI by re-selection from Type 44 of Uttar Pradesh. Some of the latest early maturing varieties from IARI are S9 and S12.

**Black Gram** (*Urad*)

About 2 million hectares are at present planted to the *urad* crop. Research work on the improvement of this crop is going on in some of the states, as a result of which early Type 9 was evolved in U.P. Type 27 and T65, medium maturing varieties from U.P., have also done well at a large number of locations. Recently, IARI have selected Urad S1 as an early maturing variety, which would fit in rotation with wheat or barley during *Rabi*. Other promising varieties are Mash 1, Mash 48, L64, NP6, NP14, B.R. 68, D6-7, T122 and Co. I.

**Gram**

There is great need for evolving early maturing and high-yielding varieties in the case of the *Rabi* pulses, which will fit in rotation with paddy or other *Kharif* cereals. Some of the promising gram selections, which are currently being grown, are Type 1 from U.P., PB7 from Punjab, PR 17 & 77 from Bihar and RS 10 & S 11 from Rajasthan.

**Pea**

Uttar Pradesh had evolved field-pea type 163 in the mid fifties. This variety has gained wide popularity not only in Uttar Pradesh, but also in some of the adjoining states, on account of excellent quality and high yield. One of the important features of this variety is its ability to yield well even when sown late after the harvest of paddy or kharif cereals. Recently, U.P. has come out with another variety, viz Type 6113 which has, at several locations, given better results than Type 163.

**Lentil** (*Masoor*)

Lantil (Masoor) is another important *Rabi* pulse which can be successfully grown after the harvest of late paddy. A very old and established variety of Uttar Pradesh is Type 36 which has shown wide adaptability and better yields at a number of locations. Some other promising lentil varieties are B77, C31, and L9-12.

## MULTIPLICATION OF IMPROVED SEEDS

All the research for evolution of improved varieties of seeds

will be of little use if the farmers do not get seeds which are genetically true to type and possess the desired physical qualities, *viz.* vigour germination and freedom from mixtures, weeds, etc. When the farmer does not get seed of the required genetic and physical qualities, the yields may turn out to be much below the expectations. For example, if purity of a seed lot is 70 percent and its viability is 70 percent, the proportion of the pure live seed of the lot comes to only 49 percent ($70 \times 70/100$). It is, therefore, not a matter for surprise that very often the results achieved at research institutes are not duplicated on the fields. Only seed with assured purity—genetic and physical, can be expected to respond to fertilizers and other inputs in the expected manner.

A mere increasing of the seed-rate may compensate for poor germination, but it cannot ensure vigorous growth or uniformity in plant population. The other aspect of quality, *viz.* freedom from admixtures and weeds is of even greater importance. Some of the weeds are noxious, and they can contaminate a whole area and prove a threat to crop production. Other weeds might not be noxious, but, would compete with the crops and bring down the yields. Admixtures might be from other varieties, undesirable plants and inert material. Some of these might be harmful and cause diseases. From the point of view of agricultural production, therefore, it is of crucial importance that the farmer gets pure and healthy seed of adapted varieties.

There is another aspect of the importance of good seed. Amongst the inputs used by the farmer, seed is the cheapest input and it forms only a small part of his cultivation expenses. Yet, on this vital input depends the return he obtains from the other much more costly inputs. All his efforts and investment would be wasted if he does not get good seeds of adapted varieties.

Interest in seed improvement programmes dates back to the Royal Commission's Report of 1929. The Royal Commission observed, *inter alia*, that :

(*a*) many of the improved varieties included in the programme of multiplication and distribution had not been thoroughly tested under conditions obtaining on farmer's fields;

(*b*) facilities required for increasing supply of breeder seed were inadequate ; and

(*c*) attention bestowed upon maintenace of purity was poor.

Among the suggestions made by the Commission were :—

(*a*) A separate set of staff within the state Departments of Agriculture should attend to seed testing and seed distribution works;

(*b*) Seed distribution in normal situations be a self-supporting activity;

(*c*) Co-operative agencies should be utilised by the state Departments of Agriculture for seed distribution; and

(*d*) Seed merchants of approved integrity and enterprise should be encouraged.

The setting up of various research institutes by the Government of India and Provincial Administrations and the promotion and co-ordination of research by the Indian Council of Agricultural Research and Commodity Committees resulted in the evolution of many new superior varieties not only of cash crops like sugarcane, cotton and jute, but also of foodgrain crops like paddy and wheat. Seed multiplication and distribution work, however, did not keep pace with the research and the Famine Enquiry Commission of 1945 and the Grow-More-Food Enquiry Committee of 1952 found that much remained to be done in this field. With the advent of the First Five-Year Plan, the use of improved seeds was made the basis of calculations for additional production of foodgrains. The seed distribution programme initiated under the Grow-More-Food Campaign was included as part of the First Five-Year Plan and a sum of Rs. 2 crores was spent on the establishment of seed farms.

The Second Five-Year Plan estimated that 10 per cent of the original target of additional production of foodgrains would be realised by the use of improved seeds. To hasten the progress of replacement of local crops by improved varieties, it was decided to decentralise multiplication and distribution of improved seeds under the Community Development Blocks. A policy was laid down that every National Extension Service Block should be served by a seed

farm and a seed store. It was decided to establish 4,328 multiplication farms of 25 acres each, at the rate of one farm for each Community Development Block. These farms were for the specific purpose of increasing breeder seed into foundation seed and were to be under the direct supervision of the Departments of Agriculture. The foundation seeds were to be further multiplied on the lands of selected farmers with the object of increasing the seed supply. The registered seed, thus produced, was to be made available to all the farmers in each village through institutional channels like Co-operatives and Panchayats.

Unlike the First Plan, which provided finance mostly on seed distribution work, the Second Plan made available large portion of the plan outlay for the establishment of seed farms. Most of these farms were established in the later half of the Plan period. The Plan outline had originally envisaged additional foodgrains production of 10 million tonnes. By the last year of the Second Plan, 55 million acres under foodgrains were estimated to have been covered with improved seeds and the additional yields from this were estimated around 1·23 million tonnes. About 20 percent of the area under foodgrains was covered by improved seeds. The coverages under improved seeds for cash crops were much higher: Cotton 77 per cent, Sugarcane 97 per cent and Jute 53 per cent.

The progress of the seed programme was reviewed periodically by the experts of the Ministry of Food and Agriculture, the Programme Evaluation Organisation of the Planning Commission and the Seed Multiplication Team of the Committee on Plan Projects. These reports showed that the programme suffered from many defects in implementation. They also pointed out several handicaps and disabilities encountered by the states. Among the shortcomings, the following were mentioned :—

> "Nucleus or breeder seed was not received annually or in adequate quantities. The seed programme was limited to a few, more important cereals and millets Too many varieties of the same crop were multiplied on the same farm. The programme of production of foundation seed of particular varieties was not properly related to the needs of the block in relation to actual requirements of different crops. Foundation seed was always not fully utilised. There was no check on

timely and proper use of foundation seed supplied to registered growers. Inspection of fields of registered growers and roguing of crops were not done timely. Disposal of registered seeds was often left to the growers themselves. A large production of registered seed was not used for sowing. Inadequate financing prevented procurement of registered seed in full. Seed processing was defective. Complaints about poor germination and impurities of seeds were common. No systematic cropping schemes of records, specific to seed production on different stages, were maintained. Cooperative Societies were not interested in handling the distribution of improved seeds as they did not find it a profitable undertaking. Storage facilities were inadequate and defective. Seed testing was done either perfunctorily or was not done. The overwhelming proportion of improved seeds used by the farmers was derived either from their own stocks or obtained from other farmers."

These deficiencies were sought to be remedied in the Third Plan. The setting up of seed testing laboratories and the strengthening of the State seed-farms was given high priority in the Third Plan programme. The target for foundation seed farms was fixed at 4,789 units with 1,19,225 acres. Actually, 2,349 farms with an area of 1,04,604 acres are reported to have been established. Of these, 2,100 farms were reported to have been provided with seed stores. During the Fourth Plan period, 6,200 additional seed stores, each with 100 ton capacity, are proposed to be set up at distribution points.

The year 1961, which was celebrated as World Seed Year by the Food & Agricultural Organisation of the United Nations was an important year for India also. It was in this year that India became a member of the International Seed Testing Association. From this year onwards, there was a rapid sequence of events in the field of seeds.

The necessity of having a sophisticated seed industry was realised in India only after the introduction of the hybrids in the country. There are a number of problems to be tackled in the case of cross-pollinated crops, and, particularly hybrids, which, unlike the seeds of ordinary varieties, are specially produced by crossing different pure lines under scientific supervision. The grain from hybrid crops cannot be used as seed. Hybrid seeds of desired

crossing have to be produced afresh every year. The desired crossing can be achieved only under scientific supervision with assured supplies of good quality seeds of the parent lines. Moreover, the hybrid seeds, thus produced, require to be properly processed to ensure healthy and pure seeds with good viability. The processing involves proper drying, cleaning, treating and bagging of seeds and requires extensive technical knowledge in this particular field. The provision of high-quality foundation seeds, mechanical processing of seeds and the certification of the seeds are, thus, the three equally important functions of any programme for the promotion of good quality seeds which require, for their efficient execution, a sophisticated seed industry with trained people, specialised equipment and skilled arrangements.

Recognising the urgency of having an efficient seed industry in the country, the Government of India had appointed in 1960, a Committee to draw up plans for a seed producing system and an outline of how it would function. The principal recommendations made by the Committee were as follows :

1. Agencies of the central and state governments be set up at once to produce "foundation" seed from the breeder seed being turned out by the scientists.
2. A private seed industry be developed as soon as possible — one stimulated by competition and the profit motive — to multiply, process and sell the production from the foundation seed it would receive from the government agencies.
3. Independent seed-certifying agencies be organised, free of either government or industry control, to assure the quality of the seed.
4. A national seed-law be passed and seed-law enforcement agencies established.
5. An aggressive educational and promotional programme be launched to persuade more farmers to use the new improved seed.

The necessity of having laboratories to test the quality and germination of the seed was found to be extremely urgent because four maize hybrids had already been released for use in the country

and others were on the way. During 1962, the first three maize seed-processing plants in India started working with the help of equipment provided by The Rockefeller Foundation.

In 1963, the Government of India set up a Central Government agency known as the National Seed Corporation in accordance with the recommendation of its Committee mentioned above. The Committee had desired this agency not to engage itself directly with the work of seed production, processing, marketing, certification, law-enforcement or with extension work with farmers; but, instead, wanted it to foster and aid other agencies having these responsibilities.

The National Seed Corporation established eight regional units, produced foundation seeds, selected a few growers to produce hybrid maize seed, put up facilities for processing and storing seed, and began operating a couple of seed-farms of its own—one in northern India and the other in South. The National Seed Corporation certified the seed produced in the country in the absence of independent certifying agencies, which were to take over this function in due course of time, and also managed purchases of required quantities of the seeds of wheat, rice and jowar from the foreign countries.

By far the most urgent need of the National Seed Corporation was to have a good number of trained people in India who knew how to grow good seed, how to process it, and then how to distribute it to the farmers. The Rockefeller Foundation and the U.S. AID sent selected young men to work with seed-producing agencies in order to facilitate their picking up the required expertise in this field. In addition to this, the N.S.C. and the Indian Agricultural Research Institute, with help from U.S. AID, The Rockefeller Foundation, and other outside agencies, began sponsoring six-week training courses in seed production with a view to accelerating the pace of the training programme.

The year 1962 has marked the beginning of the "private seed industry" with the organisation of a few small seed firms. By the end of 1969, the number of such private seed firms in India rose to over 100. The biggest seed producing firm in India is the Tarai

Development Corporation in Uttar Pradesh, which has as its stockholders, the state's agricultural University, farmers in the area, the N. S. C. and the private businessmen. This project, which is being developed with the support of the World Bank, is expected to have, under seeds, a gross area of 56,000 acres by 1973.

The passage of the National Seed Act in 1966, marked another milestone in the brief history of India's seed industry. The Act seeks, *inter alia*, to regulate the quality of seeds sold, to assure truthful labeling and to provide a legal base for certification. The Act was very timely because it was passed at a time when India was achieving adequate levels of seed production and heading towards a situation of surpluses. Attention could thus be directed towards better quality, and towards setting up an efficient machinery for selling good quality seed.

The seed production of hybrid maize, jowar, and pearl-millet increased from zero to 80,000 acres in eight years, and sizable quantities of foundation and certified seeds of wheat and rice were produced. By 1969, there were 17 main seed-testing laboratories, 149 processing plants and 7,000 farmers raising seed under contract. Also, the National Seed Corporation got about 700 persons trained in various training courses. The private seedsmen also organised active trade associations and sponsored Tonnage Clubs for those who had produced one ton of grain per acre. A farmer having produced three tons could become a "Super Tonner".

But the seed industry of India has still got a long way to cover. India's requirements are about 2 million acres for cereals only which is about 25 times of the acreage under seed in 1969. Then improved seeds are needed for soybeans, vegetables, pulses, and even grasses.

The arrangements for the production and distribution of seeds were subjected to a detailed scrutiny by the Seed Review Team which had submitted its report in 1968. The shortcomings observed by the Team were :

(*i*) Non-availability of quality breeders stock in adequate measures ;

(*ii*) Insufficiency and lack of appropriate storage facilities on seed farms.

(*iii*) The seed multiplication programme suffered in regard to purity of seeds ; and

(*iv*) There were short comings in regard to the processing of seeds and its distribution.

The Seed Review Team made the following recommendations :

1. The production of foundation seed should be concentrated on a few large farms rather than distributed among a multiplicity of smaller ones — partly because large farms are more likely to have adequate facilities and trained technical staff, and partly because inspection can be more effective when fewer farms are involved.
2. The production of foundation seed should remain largely the responsibility of the National Seed Corporation, or, in any event, in the hands of "government or quasi-government institutions", although some foundation seed might be grown by the agricultural universities and other specialized agencies.
3. The National Seed Corporation should consolidate and place orders for seed-processing equipment.
4. The State government should set up and control the regulatory agencies, and develop seed-certification services in cooperation with seedsmen and the agricultural universities.
5. The government, by "earmarking a major role, encourage the development of cooperative and private seed processing, marketing and distribution organisations. As these develop, departmental (government) agencies now engaged in the production, purchase and sale of seeds should reduce their activities in this direction.
6. The prices to be paid to farmers should be set by market forces rather than by the government, because more competition between private firms would be a healthy development.

In the Fourth Plan, great stress was laid on the seeds multiplication programme, which was described as the basis of other developments. In the Fourth Plan period, it is planned to cover 72 million hectares under improved seeds — about 25 million hectares

under HYP, 15 million hectares under multiple cropping, 8 million hectares in assured rainfall areas and 24 million hectares in dry areas.

For a successful implementation of the abovesaid programme, the following are considered the main components :

1. Continuous supply of breeder stock.
2. Adequate arrangements for production of improved seeds.
3. Arrangements for seed processing and storage.
4. Seeds Certification.

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# 3

# The Incentive Price

"Incentive Price" is the key-stone of The New Strategy. Broadly speaking, incentive price can be defined as that price which offers to the farmers, certain positive incentives for raising their farm yields. The incentives can be in the form of a comparatively higher level of prices or in the form of comparatively more certain prices or even both.

Offering of higher prices for raising production of foodgrains may, on the face to it, look a rather disarmingly simple device. A closer examination of the whole problem, however, reveals that this approach involves extremely complex calculations and, in the long run, it is rather unpredictable in regard to its long term effects upon the economy.

## FUNCTIONS OF PRICES

Influencing production is one of the functions of prices and, therefore, it may not look altogether impossible to give a boost to the agricultural production of a country by making appropriate changes in the price structure. But, then, there are other functions of prices as well, which, if not taken care of, may upset the entire balance of the economy and defeat the very purpose for which agricultural production is sought to be raised. Broadly speaking, agricultural prices have four functions to perform :—

(*i*) Influencing agricultural production,
(*ii*) Influencing consumption levels,
(*iii*) Influencing incomes ; and
(*iv*) Influencing capital formation.

1. *Influencing agricultural production*

Changes in the relative prices of various agricultural commodities may, under certain circumstances, cause transfer of resources to the production of those commodities which are offered higher prices in the market. The magnitude of the transfer of the resources may, however, depend upon the nature of the commodities involved. For instance, commodities with a comparatively high supply elasticity *viz.* cotton, jute and sugar may effect a comparatively larger transfer of resources as compared to other commodities, and *vice versa*. But the supply elasticity for a particular commodity may also change from time to time, and even from place to place.

The aggregate supply elasticity for the agricultural sector as a whole, would be considerably less, even though some of the agricultural commodities may have a very high supply elasticity. Other things being equal, the supply elasticity for a commodity will tend to be in the inverse proportion of the area occupied by it. For example, the supply elasticities for rice and wheat are much lower than those for the commercial crops such as cotton and jute. The major foodgrain crops comprise a high proportion of the aggregate of agricultural production and, therefore, display elasticity in response to the price movements. A crop occupying only 10 per cent of the total acreage would show a comparatively higher supply elasticity than say, for example, a crop that covers about 90 percent of the acreage. The smaller crops can even double their acreage at the expense of the other crops ; but the scope for the expansion of the major crops always remains little. And, in traditional agriculture, the aggregate supply response is likely to be even lower, because of the lesser use of purchased inputs and the lesser opportunities for transfer of labour resources from each other sectors of the economy.

2. *Influencing consumption levels*

Prices play a very important role in determining the levels of

consumption of the various agricultural commodities for different sections of consumers. But, it will be most unjust to leave the consumption levels of foodgrains to be determined exclusively by the prices, because a given rise in prices will mean the largest burden for the lowest income groups and the smallest burden for the highest-income groups. For the lower income groups, a rise in prices means a reduction in consumption despite an already inferior quality of diet. It may be argued that the income and price elasticity of demand for foodgrains must be extremely inelastic for the low-income groups since they are already on a minimal consumption level. But, then, it should not be forgotten that, in that case, the consumption of other goods also must have already been reduced to the barest minimum. In addition, if the bulk of one's consumption consists of food, and prices of food rise, then there is an obvious income effect reducing the quantity one can buy.

To sum up, prices, if left to themselves, are a very cruel determinant of consumption levels, because, the burdens on the various sections of the society, due to a given rise in prices, always tend to be in an inverse proportion to the incomes.

3. *Influencing incomes*

The effect of changes in agricultural prices on the income distribution appear to be somewhat diffused in the first instance. Changes in agricultural prices have two simultaneous effects : Firstly, they cause a transfer of income between agricultural and non-agricultural sectors of the economy, and, secondly, they affect the balance of income distribution between high income groups and low income groups. A rise in agricultural prices generally causes a redistribution of incomes away from low-income urban consumers and towards high-income agricultural producers. Conversely, a decline in agricultural prices has an income increasing effect on lower-income urban consumers.

Increases in agricultural prices affect cultivators' incomes in proportion to their sales of produce. The lower income cultivators generally sell a small proportion of what they produce. For a cultivator who sells only ten per cent of his produce, a ten per cent increase in agricultural price raises his real income by one percent only. For

a cultivator who sells 70 per cent of his produce, a 10 per cent increase in agricultural prices means a rise of 7 per cent in his real incomes. In actual rupee terms the difference in the incomes of the two cultivators becomes even more significant.

In regard to consumers, the rising food prices effect the real incomes in the proportion in which they spend their incomes on agricultural commodities. A given increase in prices causes a much greater hardship to the lower income urban consumers because they spend a much higher proportion of their incomes on food than the higher income urban consumers. For a low income consumer, who spends 70 per cent of his income on food, a ten per cent increase in food prices will mean a 7 percent decline in real income. For a high income urban consumer, spending only 20 per cent of his income on food, a ten per cent rise in food prices means only a two percent decline in real insome. But, as the high-income consumer spends a larger rupee sum on food, he experiences a greater pinch in absolute terms In a welfare sense, it is probably the relative changes in income which are important, particularly for low-income consumers.

The consumer situation is a bit more complicated than the producer situation. The wealthier cultivator sells a larger absolute quantity as well as a larger proportion of his crop, whereas the wealthier consumer consumes a larger absolute amount of food even though it is a smaller proportion of his total expenditure as compared to the poorer consumer.

4. *Influencing capital formation*

As in the case of income distribution, changes in agricultural prices have opposite effects in regard to capital formation in the agricultural and industrial sectors. An increase in agricultural prices encourages larger investments in the agricultural sector due to two separate factors — one being indiscriminant between high income cultivators, and the other discriminant in favour of the higher income cultivators.

The first factor operates through the prices. Higher prices increase the returns to investment by increasing the value of output. One can perhaps reasonably assume that essentially all of the output

from increased investment will be marketed, and hence the increase in gross returns would be proportionate to the price increase. But, in so far as lower income farmers market somewhat less than 100 per cent of an investment-induced increase in output, they will, as compared to higher income cultivators, have the returns to increased investment somewhat less by higher prices.

The second factor operates through the income effect. Higher incomes increase the saving pool, making farmers a better credit risk, and, thereby, encouraging lenders to lend. This influence, however, is in direct proportion to the incomes which are in turn, in proportion to the marketings. Farmers who sell only a small proportion of their output will receive only a small proportionate increase in income and, thus, very little additions to their capacity to save and to borrow.

Rising agricultural prices have an adverse effect on industrial investment. The standard explanation of the depressing effect on industrial investment from rising agricultural prices can be traced to W. Arthur Lewis, and indeed, prior to that, to Adam Smith. According to them, rising food prices cause upward pressure on money wages, and this, in turn, causes a squeeze on industrial profits, reducing thereby not only the incentive to invest on account of falling return, but, also reducing the ability to invest by reducing the pool of profits which serves as a prime source of investment funds. In practice, the effects may work directly through influences on wages and raw material costs in manufacturing industries. There may also be transfers of capital from industry to agriculture due to the prospects of comparatively higher returns in the latter.

## PRICE MECHANISM

From the above, it can be seen that changes in agricultural prices have conflicting influences. A rise in agricultural prices may cause some increase in agricultural production and increased savings and investments in the agricultural sector. It is likely to have less of such influence in the context of traditional as compared to a technologically advanced agriculture. A rise in agricultural prices will, however, be discouraging to industrial investment. Also, a rise in agricultural prices fosters an income redistribution which is in opposition to the concept of equity held in great esteem

by most modern governments. Another criticism of the rising agricultural prices is that it encourages and accentuates inflationary tendencies in a situation of short supply of agricultural inputs. All these considerations have to be kept in view while making use of the price policy as an instrument for stimulating agricultural development. Efforts to mitigate the harmful influences of one effect of price change is likely to be at the expense of further harm on another.

Important areas for a positive price policy for agricultural development are those of attempting price stabilisation in the face of fluctuating weather conditions through an open market buffer stock operation, and by mitigating the harmful effects of failure in the agricultural sector through rationing and price regulation. Buffer stock operations cannot, of course, take care of secular failures in agricultural sector and are designed primarily to reduce fluctuations in real incomes and in consumptions of low-income urban people. In so far as the results are concerned, buffer stock operations are as good as the price regulation measures and the rationing schemes.

In their report on "*India's Food Crisis and Steps to meet it*", the Agricultural Production Team sponsored by The Ford Foundation emphasised, *inter-aia*, the need for stabilization of farm prices. They were of the view that the farmers in India would not be willing to invest in fertilisers, better implements, improved seed and incur other expenses necessary for increasing production, unless they were assured of a certain minimum price for their foodgrains. The specific assurances suggested in this regard by the Ford-Foundation Team were :

1. A guaranteed minimum price publicised in advance of the planting season.
2. A market that is ready to accept the farmers' produce at the said minimum price, at the time he wants to sell.
3. Availability of this marketing facility to the farmers within a cart-hauling distance.
4. Suitable local storage for the portion of the crops which the farmer does not wish to sell at the harvest time.

All the above mentioned assurances were considered essential for facilitating increased production of agricultural commodities in

the country and signified a distinct departure from the consumer oriented price policy followed earlier. The price policy followed by the Government of India during the fifties and sixties is called "consumer oriented" because of its emphasis on preventing upward movements in the prices and the absence of effective measures to support the prices when they recorded substantial falls. For instance, it is argued, that when the prices had fallen by about one-third in 1954-55, only modest price supports were provided; but, when the prices started rising, stringent measures were resorted to for preventing their upward movement. Between 1957 and 1963, prices of rice and wheat remained quite stable. The foodgrains production failed to rise for two years after reaching the record level in 1960-61. This situation gave rise to suspicions that the prices of foodgrains did not offer the needed incentives to the producer.

## THE INCENTIVE PRICE

In the Third Plan period, efforts were made to offer suitable incentives to the producers. According to the Third Plan :

> "For achieving the high targets of agricultural production set for the Third Plan, it is important that growers should have full confidence that the additional effort and investment which are called for will yield adequate return . . . The assurance of minimum remunerative prices for important cereals and cash crops like cotton, oilseeds and jute, over the period of the Plan, will provide the necessary incentives for increasing production; thus, adding to the effectiveness of the various developmental programmes provided for in the Third Plan".

The purpose of fixing support price is to assure to the farmer that, in case, market prices tend to be lower than that, the Government will step in and buy all quantities offered to it for sale at the guaranteed price. It is obvious that the fixation of support prices does not rule out the possibility of market prices being higher than the support prices. In fact, in a situation where demand is increasing at a faster rate than supply, market prices can generally be expected to remain higher than the support prices. If this imbalance is of a severe nature, and is found to persist, then the price policy may also aim at making assential agricultural commodities available to the consumer at 'reasonable' prices.

Guidelines for determining support prices of agricultural products depend on the objectives that are sought to be achieved. Objectives of agricultural price support policies differ from country to country. By definition, support price policy seeks to safeguard the farmer against a fall in prices beyond the stipulated level. In some countries (mainly industrialised ones), such a price-insurance has the primary objective of maintaining (or even raising) the general level of farm incomes. In several other countries (especially the less developed), the main objective of support price policy is to help augment overall agricultural production, or to stimulate production of selected commodities in preference to others. Thus, the support price policies can be categorised as either 'income-oriented' or 'production-oriented', on the basis of the *primary* objectives that they seek to achieve. As the guidelines for determining income-oriented support prices will basically differ from those for production-oriented support prices, the question arises as to which of these two types of support price policies is relevant in the context of the Indian situation.

## THE SUPPORT PRICE POLICY

The objective of the income-oriented support price policy is to maintain a desired relationship, often with reference to a selected base period, between prices of agricultural and non-agricultural commodities as a whole, and thereby to assure a historical parity, not necessarily equality, between farm and non-farm incomes. The classical example of the income-oriented support price policy is provided by the U.S.A., where support prices are determined with the objective of giving agricultural commodities the same buying or purchasing power that they had in a selected base period, when prices received and paid by farmers were considered to be in a position of balance. Price policy, when used as an instrument for attaining desired income objectives, has to be necessarily guided by welfare criterion, and not by the principle of marginal allocation of resources. Even in the U.S A , there has been a good deal of valid criticism of the parity price approach. The most important drawback of parity prices is that they are backward-looking, and that by seeking to perpetuate past price-relationships, they do not allow

the price mechanism to perform its essential function of resource allocation within agriculture and also between agricultural and non-agricultural sectors. It needs hardly to be stressed that in a developing economy like ours, which should be progressive and forward-looking, any price policy aiming at perpetuating the price-structure, resource allocation and production pattern of any past period, is absolutely unsuitable. Moreover, income-oriented support policies in developing countries like ours, would have another important limitation. In these countries, large transfers of income from sectors other than agriculture are not possible, as incomes from agricultural sector constitute a sizeable part of the national income. The extent to which the agricultural income support, as an objective, can be undertaken is, therefore, very much limited. This, however, does not imply that the level of agricultural incomes or efforts to increase it are not important considerations in policy formulation in developing countries. As a matter of fact, most of these countries strive to increase agricultural incomes by augmenting agricaltural production and productivity as a part of overall economic development. What has to be recognised is that, in such developing countries, support price policy *alone* is neither an adequate nor a desirable instrument for raising agricultural incomes.

As the primary objective in the context of Indian situation is to step up the rate of growth of agricultural production, with a view to meeting the steadily rising consumer demand, a production-oriented support price policy would seem to have a greater relevance. The basic hypothesis of the production-oriented price support policy is that production responds to price stimulus. A question may be raised as to whether this hypothesis is valid in a developing economy, where a large part of the agricultural activity is subsistence-oriented, rather than market oriented. Although prices would have a greater measure of influence in the case of cash crops as compared to the subsistence crops, yet there is a growing volume of evidence to show that with some degree of monetization and transport facilities, a fairly large proportion of peasants respond, to some extent, to prices and other economic incentives. Moreover, the role of the support price policy acquires an added significance when increase in agricultural production has to come about mainly through new

investments in resources. Augmenting agricultural production is possible in the context of the present agricultural organisation in our country, only if the farmers' co-operation in undertaking necessary investment is forthcoming. In as much as the guaranteed support price would reduce the risk arising out of a price fall beyond the stipulated level, support price policy can help in creating a climate of confidence, conducive to a greater investment effort by the farmer.

It is important to understand that though the price support policy is a necessary instrument for bringing about increases in agricultural production, it would be ineffective without other supporting measures. The incentive of the support price policy should not be allowed to be blunted by disincentives arising out of a regressive tenurial arrangement or credit restrictions or structural imperfections in the marketing of agricultural products. Further, price support policy can, at best, provide an inducement to the farmer to increase production ; whether in fact production will increase or not will depend, *inter-alia*, on the availability of physical inputs as well as their supply elasticity. If input supplies are relatively price inelastic, increase in support prices may only tend to result in cost inflation. These factors are, therefore, important determinants of the efficiency of the support price policy.

A question may arise whether there is any need for a support price policy when prices are generally high and, on the whole, continue to rise. It seems that the need for support price policy, even in a situation of high and generally rising prices, can arise on account of two considerations. Firstly, even though prices are generally rising, possibility of prices declining, sometimes even steeply, cannot altogether be ruled out, especially during the immediate post-harvest period, and/or in heavily surplus pockets, where potentiality of production to rise is often high. Moreover, the biological character of agricultural production also results in year to year fluctuations in production. As a result, in years of sizeable increase in production, prices decline quite steeply, to even what may be described as 'unremunerative' levels. Secondly, an enviornment of high but uncertain prices cannot be considered ideal for inducing farmers to

undertake new investments for increasing agricultural production. There is much truth in the hypothesis that stable, even though somewhat low prices, are more likely to induce farmers to increase production than high but fluctuating prices.

It may also be asked whether support prices would have any influence on the production decisions of the farmer when market price, and, consequently, the prices realised by the farmer are higher than the support prices. Prices actually realized by the farmer can, no doubt, be expected to provide an important basis on which the farmer may base his price expectations. Even then, it would not be valid to assume that support prices would not at all influence the farmers' price expectations, except in case the support prices are not fixed at unrealistically low levels. In the first instance, a realistic support price can raise the average realised price by not permitting even the post-harvest prices to be lower than the support prices. Secondly, fixation of the support prices provides a floor to the price probability calculations of the farmer, and, thereby, induces him to work nearer the optimum point on his production possibility curve. High prices realised in the present cannot in any way lend certainty to future also. Support prices can reduce the uncertainty of the future by indicating the floor below which market prices will not be permitted to fall and, thereby, promote a rational use of farm resource. However, the effectiveness of the support prices in achieving this objective would, to a large extent, depend on the level of the support prices. If they are fixed at very low levels they would hardly enter into the farmer's decision-making calculations.

It may be agreed that the main role of the support prices is to help create a favourable climate for augmenting agricultural production; but, then the question arises as to which decisions of the farmer the price support policy should strive to influence, and how best it can be done in actual practice. Among the various decisions that a farmer has to take, the important ones relate to :

(*a*) choice of crops; and

(*b*) combination of resources (including the choice of production technique).

Although little is known about the decision making process, it

can be assured that the farmer bases his decisions about what to produce and how to produce, on some economic calculus in which expected prices of products and of inputs occupy an important position. Decisions relating to the combination of resources and the choice of production technique may be influenced by the expected relationship between costs (as determined by input prices) and returns (as determined by output prices). Similarly, it is the expected inter-relationship between the prices of competing crops that may influence the choice relating to the produce. It is from this angle, therefore, that the claims of cost of production as well as the inter-crop price parities have to be considered as guidelines for determining support prices. This again involves a number of problems.

First and foremost, is the problem of having some basis on which the price may be fixed. A common practice in this regard is to have the past data on cost of production of agricultural commodities as the basis for the fixation of the support price The main argument in favour of this approach is the elementary necessity that the price should cover the cost of production: otherwise, the producer will, sooner or later, give up production. Apparently, this cost of production approach appears to be quite simple and fair; but, on closer examination, it is found to involve problems that are at once varied and complex. In this regard the main questions that need to be answered are :

(*a*) what costs to consider ; and

(*b*) whose costs to consider.

The main problem relates to the inclusion of family labour as a cost item. The argument against including family labour as a cost item and evaluating it at the market wage-rate, either for permanent or casual labour, rests on the consideration that the opportunity cost of the farm family labour in India is almost nil. If by this it is meant that there are no alternative avenues of employment for the farm family labour, and that it will continue to be engaged in farming, whatever the price of the product, it is no more than a truism. However, this line of reasoning is, at best, applicable to a largely subsistence-oriented farming, and is not quite appropriate when the objective is of transforming peasant farming into a market-oriented

business proposition. Moreover, though as a general hypothesis, the nil opportunity cost proposition may not be incorrect, yet it is important to reckon that the opportunity cost of labour during certain peak periods in agriculture is very high. If, therefore, the principle of opportunity cost has to be followed, it is more appropriate to determine the opportunity cost of labour at different periods during the season and evaluate it accordingly, rather than take it as of nil value throughout. But, the complexities of evaluating the opportunity cost of farm family labour are so numerous that every serious exercise in this regard assumes the significance of intellectual kite flying only.

An important argument against the inclusion of farm family labour as a cost item and of evaluating it at the prevailing wage rate is that it unduly inflates the cost figure, especially because the small farmers push the use of labour input to the point of zero marginal return. This, however, does not imply that the small farms are run inefficiently. In fact, on most small family farms, labour is largely used as a substitute for other inputs, especially for capital, and, therefore, it has as much claim to be regarded as a cost item, as any other input. But, still, the question remains, whether the labour used on small farms would be pushed as far as the point of zero marginal return if it were the hired labour ? If the answer is in the negative, then the economic logic would question the propriety of evaluating the farm family labour at the prevailing wage rate.

Another question that arises is as to whose cost of production should be taken into account for determining the support price ? Cost of production of a commodity depends on a number of factors which vary from farm to farm *e.g.* size of the farm, soil type, cropping pattern, farm investment, as well as technique of production employed. Since structure of farm business and/or the technique of production would differ, often widely, as between different farms, the cost of production of a commodity would also vary between different farms and regions. Hence, the problem of aggregation has to be resolved if the cost of production is used as a basis for determining support prices. In this connection these aggregate cost estimates can be considered :-

(*a*) average cost of all farmers ;
(*b*) bulk-line cost ; and
(*c*) average cost of efficient farmers.

Average cost, though useful in providing valuable background information, can hardly provide a satisfactory basis for determining farm prices. If support prices are related to the average cost of production, it is clear that a majority of farmers would still have costs higher than the average cost. The question also arises, whether average costs of production are at all relevant when the objective is to augment production. It is, therefore, the marginal cost of production which may need to be covered rather than the average cost of production. The alternative of bulk-line cost is often suggested with a view to relating the support price to the marginal cost of production. Bulk-line cost has been defined as that cost which would cover the cost of producing about 85 per cent of the total output. In a sense, therefore, the bulk-line cost is the marginal cost of producing the 85th unit of output, assuming that a total of 100 units of the commodity is being produced. Though the limit of 85 per cent of production is only arbitrarily fixed, and can hardly have any defence in economic logic, yet the bulk-line cost is the nearest real world approximation to the economist's concept of marginal cost. However, bulk-line cost approach based on past cost structure, has a basic limitation : it assumes that the technique of production would remain static. If the objective is to increase agricultural production, the bulk-line cost approach would lose much of its appeal. It may also be questioned whether support prices based on past bulk-line cost would necessarily provide the inducement to the farmer to undertake new investments for increasing production.

The idea of linking support price to the cost of production of efficient farmers merits serious attention in so far as it is primarily production oriented. The logic of this approach is that while efficiency must be rewarded, inefficiency must not be encouraged. In order to translate this approach into practice, the question of defining the efficient farmer has to be satisfactorily resolved. It is obvious that efficient farmers are not necessarily big farmers. Farm management studies in India have shown beyond doubt that efficient farmers as well as inefficient farmers are found in all size-groups.

Various criteria can be thought of for distinguishing efficient farmers from the inefficient ones, *e.g.*, cost per unit of output, yields per acre, gross value of production aer acre, returns per unit of capital invested, use of improved technology etc. Each of these criteria deserves careful consideration. It may, however, be mentioned that efficiency has relevance only with respect to a given farm structure. The structural imbalance inherent in our agriculture may make some farms look inefficient, though in actual practice they may not be so. The technological efficiency has also to be distinguished from economic efficiency. All these considerations underline the fact that there is no simple formula distinguishing the efficient farms in the existing structure and organisation of Indian agriculture.

Cost of production approach, though useful for some purpose, is essentially a backward-looking approach. Given a certain level of technology, the linking of support prices with past costs of production, howsoever defined and measured, can at best succeed in guaranteeing certain income levels to the farmers. It cannot ensure that support prices should ideally be related to the supply responses to price stimuli. Various economic models for estimating supply responses can be thought of. These models fall into two broad categories :

(*a*) those based on aggregative time series ; and
(*b*) those based on micro sources of data.

Most of the supply response studies based on time series data have been in the form of regression analysis. Though these studies have, by and large, provided useful insights into the historical relationship between prices and production yet their value as a tool for predicting long-term supply responses has been found to be very limited because they do not adequately deal with the institutional, structural and technological changes. The problems of aggregation and estimation further restrict the utility of these studies. The supply response models based on micro-sources of data can be cost-function models or production-function models or linear programming models.

Although it is theoretically possible to derive both short-run and long-run supply responses through these economic models,

the co-efficients so obtained are generally not very stable and, therefore, cannot be used with confidence. The biggest single limitation of these models lies in the assumption of a static framework. Moreover, the type of data needed for building up these models are not available in most of the developing countries. As a result, the utility of the supply response functions is extremely limited in developing a rational structure of support prices.

While, thus, the sophisticated economic models have limited value in the present context as a basis for determining support prices, it is necessary to relate support prices to costs of and returns from improved technology, so as to provide an adequate inducement to the farmer for augmenting agricultural production through the adoption of improved technology. It may, however, be argued that improved technology, by definition, is cost reducing and, therefore, there may not be any need for providing any incentive to the farmer for adopting it. But, there exist important psychological handicaps in the way of rapid adoption of improved technology. The apparent advantages accruing from the adoption of the improved farm technology are subjected to a two-way cut by the farmers ;

(*i*) by way of heavily discounted expected output estimates ; and

(*ii*) by way of inflated expected cost estimates.

The logic underlying the farmer's behaviour as hypothesised above is understandable if we cousider the nature of innovations in agriculture. The improved agricultural technology is highly capital intensive and calls for a substantial rise in investment. Given the asset structure of most of the Indian farmers and the generally unpredictable flow of vitally needed farm inputs like rainfall and fertilizers, heavy output discounting and cost inflating can be adequately defended even on a purely theoretical plane. Hence, in order to induce the farmer to adopt improved technology, the support prices should be fixed at such levels as would give the farmer an income which will be sufficiently higher than the income that he would have obtained had he not adopted the improved techniques of production, so as to adequately cover the element of risk.

If the optimum net income per acre under existing level of technology is Y, the average farmer will be willing to adopt the improved technology only if he is sure of realising a net income

equivalent to Y plus an adequate margin for risk and uncertainty arising out of the adoption of improved technology. If the risk and uncertainty margin is denoted by Z then the adjusted optimum net income per acre may be denoted $Y^1$ so that

$$Y + Z = Y^1$$

If the total cost corresponding to the levels of improved inputs that are recommended to the farmer for adoption is denoted by C, the gross expected income of the farmer, under improved technology should be equal to the sum of adjusted optimum net income (net income under existing technology plus a margin for risk and uncertainty) and C. Let this gross income be denoted as X so that we have :

$$Y^1 + C = X$$

If we divide X by the output level O corresponding to the given levels of improved inputs, we get the estimate of the support price P. In other words the support price $P = \frac{X}{O}$.

The above 'modified production function' approach has, no doubt, several limitations. In the first place, it has been assumed that farmers are optimally combining their resources under the existing levels of technology. This assumption can, to some extent, be justified on the basis of empiricial findings of some of the recent studies which show that farmers, by and large, use their resources in an optimum manner, given the shape of the production surface under their traditional techniques of cultivation. Another important assumption in this approach is that a given combination of inputs as represented by the recommended package, has been taken as the basis for estimating output and cost under improved technology. It may also be noted that this approach gives only a point estimate and it does not tell us about the shape of the supply response curve. However, it is possible to derive a supply curve by adopting different input combinations, *i.e.* different variations of the package. Since the formulation is essentially based on the production function model, the shortcomings of the latter are valid in this case also. It may, however, be mentioned that the model has given very interesting results in some preliminary testing based on the composite demonstration data from the Intensive Agricultural District Programme Areas.

The levels at which support prices should be fixed would also depend on the levels of input prices. Output and input price ratio is an important factor influencing the growth of the overall agricultural output. Favourable price ratios can be brought about both by raising output prices and by lowering input prices. A choice between these two alternatives has to be exercised with great care because both the alternatives have advantages and disadvantages. The main advantage of subsidising input prices is that the cost of subsidy programme is directly related to the propagation of practices that increase productivity. The cost of subsidies can be borne through the tax system so that the unfavourable impact of higher agricultural prices on the non-agricultural sector can be avoided. Further, subsidy will benefit only those farmers who are innovators. Raising product prices will increase incomes of both innovators as well as non-innovators. If farmers' marginal preference for leisure is higher relative to labour, higher incomes coming through higher product prices may, to some extent, blunt the incentive to increased productivity.

It can be argued in favour of higher product prices, that input subsidies are of not much help in a situation in which increase in agricultural productivity comes from a more intensive use of non-purchaseable inputs that are not complementary with purchaseable inputs. Secondly, if the use of purchaseable inputs is already widespread, it is doubtful whether the mere lowering of the price of inputs will induce more farmers to go in for higher use of inputs.

Thus, it is not possible to say, *a priori*, whether preference should be given to either higher product prices or to input subsidies. The factors that would help a decision in this regard are : (*i*) existing level of inputs use ; (*ii*) possibility of raising output price ; (*iii*) relative importance of low cost and provision to the farmer of a cushion for risk taking ; and (*iv*) ease or difficulty of administration of input subsidy and the value judgment regarding income distribution between agricultural and non-agricultural sectors as also income distribution among different farms. It may, however, be emphasised that in order that the desired objective of wider adoption of new and improved techniques is achieved, inter-relationship

between product prices and input costs is of fundamental importance and the desired relationship will have to be attained in practice by a judicious combination of variations in both prices and costs.

The need for the inter-crop price relationship (parity) approach as mentioned earlier, is based on the hypothesis that prices of competing crops would influence the farmer's decision relating to the choice of areas and products. The theoretical basis of this hypothesis is that a change in the price of a product would disturb the equilibrium of the farm and start a process of readjustment of resource-use and, consequently, of output levels of different products. There is considerable empirical evidence to show that farmers respond, in varying degrees, to changes in prices by re-allocating acreage under different crops Thus, both theory and available empiricial evidence indicate that the inter-crop price relationship is an important factor in influencing farmer's production decisions.

Most of the acreage response studies attempt to correlate shifts in acreage under a crop with variations in the price of that crop or in the price ratios of competing crops. Usually, this relationship is studied with reference to time series data based on actual observations of acreages and prices of commodities.

If adequate and reliable data on production (acreage) responses to price variations is available, the ideal solution would be to make a detailed study at the beginning of each crop year, of the supply and demand position of each crop and then make marginal adjustments in the support price of each crop in the light of the supply (acreage) response coefficients. While, as a general proposition, it seems reasonable to conclude that the relative prices of competing crops should be fixed in such a manner as would bring about the desired production pattern, the question arises whether, and to what extent, response coefficients obtained with reference to past relationship between price and acreage (production) would hold good for future projections. Price is only one of the variables influencing farmer's decision regarding choice of crops. There are many other important factors like technological innovations, structural changes etc., which also vary over time. There is also the problem of aggregation at the all-India level, of results obtained from regional studies with varying crop complexes.

In view of the foregoing, it may be said that the present knowledge does not enable us to evolve a cut and dried formula for determining support prices. Much more empirical evidence will have to be collected and analysed for a number of years to come, before any attempt at evolving a scientific basis for fixing support prices can begin to yield results. Even then, it is very doubtful whether it would be either feasible, or desirable, to reduce the support price determination process to any rigid mathematical formula approach. There is no substitute for adjustments in the field. **Price mechanism is a highly sensitive and delicate instrument** and the repercussions of a change in price in one area would be so wide-spread that it seems almost an impossible task to take into account all of them and to arrive at an integrated price structure that may be truly described as in equilibrium, both over space and time. Nevertheless, attempts to collect and analyse as much empirical evidence as possible, will have to continue and to be intensified so as to derive supply response co-efficients which can serve as guidelines for determining support prices. The empirical evidence that is available in this respect at present is so limited that, at best, it can serve only as a qualitative pointer rather than a quantitative determinant. Efforts at systematic collection of data on costs of production of the farmers, will have not only to continue, but also to be intensified, so as to provide valuable background information for price fixation. Moreover, data on cost of, and return from improved practices, especially in the Intensive Agricultural District Programme areas, will have to be analysed. Also, the relationship between product prices and input costs will need to be revised from time to time. However, it should be clear beyond any doubt that the primary objective of the support price policy in India has to be that of augmenting agricultural production and not of achieving income redistribution between agricultural and non-agricultural sectors. The guidelines for determining support prices will have to be evolved keeping this objective firmly in view.

## THE JHA COMMITTEE (1964)

Considering the vexed nature of the problem of fixing support prices, the Government of India appointed on 1 8.1964, a Committee to advise on the determination of the prices of rice and wheat for the 1964-65 season. The Committee was asked to advise on :

(*a*) The determination of producers' prices in respect of the 1964-65 season, first for rice and then for wheat, on an all-India basis, with such quality-wise and region-wise variations, as might be necessary, fair and economical and also the reasonable wholesalers' margins, retailers' margins and consumer prices ;

(*b*) the terms of reference which would be suitable for an agency to provide such advice on a continuous basis in respect of future seasons, the suitable form of such agency, and the kind of personnel it should have ; and

(*c*) the best manner in which the work of such an agency could be fitted in with arrangements being made for advice on policy in regard to wages, incomes and savings.

Later, the Committee was also asked to suggest prices of coarse foodgrains for the 1964-65 season.

The prices recommended by the Committee were in the nature of the minimum prices which were to be assured to the farmer through price support operations. This, however, did not imply that the producers' price was to be kept down to the minimum level. The prices recommended for wholesalers and retailers were such that the producers of paddy could secure a rupee or two more than the minimum proposed prices.

The Committee recommended that while the fixation of maximum prices for wholesalers and retailers should keep paddy prices from rising too high (and they had, therefore, not recommended any maximum price for the producer), in the eventuality of the paddy price tending to rise by more than Rs. 2 per quintal, the declaration of stocks by producers and compulsory procurement at that price should not be ruled out for maintaining the consumers' prices.

The Committee recommended the producers' price for only one important coarse variety of paddy in each state and left to the state governments the detailed working out of the commensurate prices for the coarse, medium, fine and super-fine varieties of paddy in accordance with the normal marketing differentials, as well as the differentials allowed in the maximum prices, wherever fixed.

In the eventuality of hoarding, the Committee favoured the

government requisitioning of paddy stocks from the trade, if necessary.

The Committee was also asked to recommend the terms of reference which would be suitable for an agency to provide, on a continuing basis, advice on price policy and price structure in future, the suitable form of such an agency and the kind of personnel it should have. Observations made by the Jha Committee are given in Appendix IV.

## THE AGRICULTURAL PRICES COMMISSION (1965)

In accordance with the recommendations of the Jha Committee, the Agricultural Prices Commission was set up on 8th January 1965. The terms of reference of the Commission were as under :

1. To advise on the price policy of agricultural commodities, particularly paddy, rice, wheat, jowar, bajra, maize, gram and other pulses, sugarcane, oilseeds, cotton and jute with a view to evolving a balanced and integrated price structure in the perspective of overall needs of the economy and with due regard to the interests of the producer and the consumer.

1.1. While recommending the price policy and the relative price structure, the Commission was to keep in view the following :—

(*i*) The need to provide incentive to the producer for adopting improved technology and for maximising production;

(*ii*) The need to ensure rational utilisation of land and other production resources ; and

(*iii*) The likely effect of the price policy on the rest of the economy, particularly on the cost of living of wages, industrial cost structure, etc.

1.2. The Commission was also to suggest such non-price measures as would facilitate the achievement of the objectives set out in 1 above.

2. To recommend from time to time, in respect of different commodities, measures necessary to make the price policy effective.

3 To examine, where necessary, the prevailing methods and cost of marketing of agricultural commodities in different regions,

suggest measures to reduce costs of marketing and recommend fair price margins for different stages of marketing.

4. To keep under review, the developing price situation and to make appropriate recommendations, as and when necessary, within the framework of the overall price policy.

5. To keep under review, studies relating to the price policy and arrangements for collection of information regarding agricultural prices and other related data and suggest improvements in the same.

6. To advise on any problems relating to agricultural prices and production that they may be referred to it by Government, from time to time.

The Commission was required to maintain close touch with other agencies dealing with matters having a bearing on prices and production, including the steering group on Wages, Incomes and Savings policy and the Food Corporation of India.

The Commission's recommendations and other aspects of Price Policy for Kharif cereals for 1965-66, were presented in a subsequent report on the 30th June, 1965. These were considered at the Chief Ministers' Conference in July 1965, and later at meetings of the Committee appointed by it on 31st July and 1st August 1965, and finally at the Chief Ministers' Conference held on 6th August 1965, when the Government announced their decision regarding the Food Policy for the 1965-66 season. Besides making recommendations of prices for the 1965-66 season, the Agricultural Prices Commission also considered, in detail, the long-term food policy. Views of the Commission on the various aspects of the food policy are given below :—

1. *Long Term Food Policy*

> "As long as a sizeable supply gap continues, it will not be possible to build buffer stocks in the real sense of the term. In this situation, the only way of achieving the objective of maintaining a position of strength in the foodgrains market is to acquire 15 to 25 per cent of the marketable surplus of rice every year and distribute it through a system of Fair Price Shops and rationing.

We do not think that, in the present context, the Government can acquire the requisite stocks through competitive purchase in the open market, though the Food Corporation of India and the cooperatives may make such purchases wherever possible. The major part of public stocks will, therefore, have to be procured through a system of levy on producers/millers. Procurement should be undertaken in the surplus as well as the deficit States. The total quantity of purchases required would vary, according to the policy in regard to inter-state movement. The rate of levy will be uniform if there are no movement restrictions, but it will have to be higher in the surplus States if movement restrictions continue.

We do not favour monopoly purchase/procurement on the ground that the quantities thus acquired will fall short of the requirements of the non-producer consumers. Since there will be no buyer except the Government, the prices offered by the Government, however, reasonable they may be, would be considered low and unfair by the farmers. In consequence, they will not deliver to the Government, the entire-marketable surplus."

2. *Inter-State Movement Restrictions*

"On movement restrictions, our views are not unanimous. All of us agree that movement restrictions imposed on private trade, if not compensated by planned movement on Government account, would lead to price distortions, adversely affect the allocation of resources — particularly in respect of regional cropping patterns — and more importantly, generate a feeling that injustice is being done to the consumers in the deficit states and to the farmers in the surplus states. Yet, the majority of us thinks that in the prevailing situation of an acute supply gap, it would be too risky to depend on the private trade to distribute the available supply equitably over all regions without an excessive rise in prices For the next season, we, therefore, recommend the continuation of the Single State Zones. We have examined the case of restoration of the larger zones, but find no particular advantage in it. We would, however, like to emphasise strongly that the system of Single State Zones imposes a rigid discipline which everyone concerned will have to observe scrupulously. Briefly, the discipline involves the willingness to share the national shortage equitably. The surplus or the deficit of each state should be determined on the basis of an agreed objective criterion. A National Food Budget should be prepared for the purpose."

3. *Procurement*

"For the 1965-66 season, the acquisition of rice by the Government (Central and State) should not be less than 22 lakh tonnes (including 5 lakh tonnes imports). If Single State Zones continue, this quantity will have to be stepped up to about 40 lakh tonnes, as compared to 38·6 lakh tonnes acquired during the current year. Of the 40 lakh tonnes which would be needed during the 1965-66 season, the acquisition on Central Government account will have to be about 25 lakh tonnes — 20 lakh tonnes from domestic production and 5 lakh tonnes from imports. In the current year, the corresponding figures are 24·6 lakh tonnes — 16·8 lakh tonnes expected from domestic sources plus 7·8 lakh tonnes from imports. Moreover, the State Governments will have to procure about 15 lakh tonnes during 1965-66 season as against 14 lakh tonnes in the current year. The implications of accepting this commitment should be carefully considered."

4. *Price Control*

"Besides the minimum support prices, we have suggested that only the prices for the Government purchase of rice should be fixed — the rest of the marketable surplus should be allowed to be sold at the open market prices. In the absence of sufficient (uncommitted) stocks, maximum wholesale prices are difficult to enforce — when such enforcement is needed most. Attempts to keep them within the ceiling by resort to coercive authority have invariably failed. They succeed only in distoring the flow of the marketable surplus and pushing it underground. On the other hand, allowing the non-levy portion of the marketable surplus to be sold at free market prices, would help the acquisition of large stocks by the Government. Sale of 15 to 25 per cent of the marketable surplus through Fair Price, Shops is, in the prevailing situation, the only instrument available to the Government for containing the rise in prices."

5. *Coarse Cereals*

"In view of the limited extent of inter-state trade, no restrictions on movement or prices of coarse cereals should be imposed, nor purchases undertaken except as commercial purchases. If, however, the above policy cannot be adopted uniformly all over the country, and some states deem it necessary to impose movement restrictions, then it is essential that the outflows and inflows of all the concerned states be determined on a rational basis by the Central Government in consultation with all of them. Quantities to be moved should be determined so as to ensure that the states deficit in coarse cereals get their minimum requirements."

The Agricultural Prices Commission has been making recommendations for the fixation of procurement prices for different foodgrains from 1965-66 onwards. It has, however, been observed that the prices actually fixed by the Government of India have been generally higher than those recommended by the Commission. It is important to note that the Agricultural Prices Commission, though considered to be a body of competent economists, capable of rendering technical advice in regard to the fixation of prices, is not the final authority in so far as the matters relating to the fixation of prices are concerned. The recommendations of the A.P.C. are more or less in the nature of a technical advice which has to be approved by the Government of India, keeping in view the various other factors which may or may not have any relevance to the field of economics as such. The recommendations of the A.P.C. are considered by the Chief Ministers of the states and the final prices are decided upon in accordance with the consensus in the Chief Ministers' Conference. The consensus has, however, generally been found in favour of fixing the prices at levels higher than those recommended by the Agricultural Prices Commission.

This procedure of fixing the prices for foodgrains has been objected to by certain eminent economists, including Prof. M.L. Dantwala, who also happened to be the Chairman of the A.P.C. for the period 1966-68. According to Prof. Dantwala "The Commission was asked to keep in view the likely effect of the Price Policy on the rest of the economy, particularly on the cost of living, on wages, and industrial cost structure. But the only reference which the politicians appear to have accepted — to the exclusion of others — is the need to provide incentive to the producers. While these incentives do help in the expansion of production, an increase in product prices ceases to perform that function beyond a point, when input availability becomes a bottleneck."

The Agricultural Prices Commission also had drawn attention to "the international implications of interminable increase in the domestic and especially food prices." Over a large number of Indian industry, the unit cost of production had been substantially higher than the corresponding international costs. The Commission had stressed the point that the spiralling of prices had restrained

investment and held back essential development. In the words of the Commission "The rise in foodgrain prices had been the single most important element stoking the fire of inflation." Prof. Dantwala very much regretted that all the above said arguments were not given due consideration by the Chief Ministers, who, judged economic issues in the light of their political implications only.

Prof. Dantwala also mentioned a method by which some of the state governments sought to push up prices, though remaining within the framework of the recommended prices. The Agricultural Prices Commission and the Government laid down the procurement prices only for the common or standard variety and left it to the state governments to fix margins for the superior varieties. An Expert Committee had suggested that the price differential between rice varieties of different crops should not be in excess of Rs. 5/- per quintal. But, taking advantage of the option given by the Union Government to fix the differentials, several state governments widened the differentials inordinately.

From the above, it can be seen that due to various reasons and through various methods, the prices of foodgrains in the various states were fixed at levels which were much higher than even those recommended by the A P.C. This was largely attributable to a strong desire on the part of the Chief Ministers of the surplus states for ensuring to their farmers, handsome rewards for their efforts for rearing farm yields.

# 4

# Infrastructure

The word infrastructure has a rather interesting history behind it. It is said to have originated as a military term during the Second World War and was applied to such items as oil pipe-lines. Subsequently, its scope was enlarged so as to include various other capital items. After the Second World War, the term was generally used as a substitute for the "Social overhead capital" with a view to avoiding confusion with hospitals, schools and similar other welfare type facilities. Many experts, however, still use the terms infrastructure and "social overhead capital" interchangeably.

The word "Infrastructure" has also been defined as the basic services on public utilities which are necessary to the commodity-producing sectors of the economy. Infrastructure and superstructure are both complementary parts of a single structure. The superstructure is directly useful for serving specified functional purposes and infrastructure is there to sustain it.

Infrastructure comprises all those facilities and activities, the basic rationale of which is to provide sustenance to income generation and production activities in the rest of the economy, rather than income generation and production within the infrastructure enterprises themselves. The bulk of benefits from any infrastructure enterprise accrue to the society, more in the form of higher levels of production and income outside that enterprise rather, than within the enterprise. The profits of infrastructure enterprise accrue, more often than not, in the accounts of the enterprises of the rest of the

economy, rather than in the accounts of the infrastructure enterprises themselves. Because of the shift of profits, the profitability in the infrastructure enterprises is usually lower than that in the superstructure enterprises. This is true in every country of the world. Thus, in almost every country, the profitability rate of railways is always one of the lowest. Post and telegraphs are not particularly known for good profits in any country of the world. And in regard to roads and education, it would generally, and rightly, be considered as something preposterous even to raise the question of profitability. It is generally understood that the profits on investment and outlay in these activities, which are really very large, would be reflected only in the rest of the economy.

The private enterprises which usually take investment decisions on the basis of expected profitability would generally tend to shun the infrastructure activity. This tendency on the part of the private entrepreneurs is further strengthened by the fact that the infrastructure activities have not only an unusually long period of gestation, but, also a further period of several years, if not decades, of operational losses. But usually, the private entrepreneurs are not prepared to wait that long; they prefer that the profits should start flowing much sooner. Hence, if the construction of the infrastructure is left exclusively to the private sector, the job would remain, by and large, undone. For these reasons the job of creating the infrastructure was sought to be entrusted to the public sector in India from the very beginning of the Planning.

The superstructure yields reasonably attractive profits and has a short gestation period in respect of its construction and non-profitable working. So it can be left, by and large, to the private sector. The reverse is the case in respect of infrastructure. Hence, the responsibility in this sphere should be shouldered mainly by the public sector. These considerations explain the government endeavours to expand the public sector in India. This can be seen from an analysis of the public sector outlay under various plans. About 4/5th of the planned effort is directed towards the building up of the infrastructure which is of crucial significance for the growth of the economy as a whole.

Much can be said about the inefficiency with which the infrastructure constructions are carried out and inefficiency with which they are operated. But, even after taking into consideration all relevant factors, one has to appreciate the role that the public sector has played in helping the functioning and expansion of the private sector in the Indian economy. In physical terms, the growth of infrastructure in India, though still inadequate, has been impressive.

Infrastructure can be divided into "economic" and "social" infrastructure ; the former comprising services such as power, irrigation, transport, communication, banking, insurance etc. and the latter consisting of services and amenities like water-supply, sewerage, education, medical and health services, housing etc.

Although the important items of the infrastructure remain about the same, the diverse requirements of industry and agriculture may recommend quite different, or even mutually contradictory patterns for their growth. For instance, in a given area, the plan for extension of electric power in a particular manner may be most advantageous from the point of view of the development of industry ; but it may not assure optimum benefits to agriculture in that area. It can also be the other way round. Similar is the position in regard to the development of transport and communications and also other items of infrastructure. The development of infrastructure in a given area, therefore, depends upon the requirements of industry and agriculture in that area.

Important items of infrastructure for the growth of agriculture are as under :—

1. Agricultural Credit.
2. Agricultural Marketing.
3. Storage and Warehousing.
4. Research.
5. Education and Training.
6. Power.
7. Transport and Communication.
8. Administration.

## 1. Agricultural Credit

Agricultural Credit constitutes a very important item in the infrastructure for agricultural development. By the end of the Fourth Plan, 25 million hectares will be brought under the high-yielding varieties of foodgrains and consumption of fertilizer in terms of Nitrogen will go up to 3·2 million tonnes by 1973-74. This has far-reaching implications from the point of view of credit requirements. With the increased use of modern inputs, the cultivators have to incur a large expenditure than that incurred in the past. This may compel many of them to borrow, which they might not have done under the traditional pattern of cultivation. As a result, rural credit needs are expected to expand both quantitatively and qualitatively.

There is also a pressing need for increasing capital investment in agriculture, mainly in minor irrigation *i.e.* for construction of new wells, deepening of existing wells and the installation of diesel or electric pump-sets, because the cultivation of high-yielding varieties and larger use of fertilizer requires an increased and assured availability of water. Investment is also required for mechanization which becomes necessary under an intensive pattern of cropping.

A large demand for farm credits is thus building up for wells and pump-sets as also for the purchase of machinery, such as tractors and power-tillers. In the command areas of certain major irrigation projects which are nearing completion, full advantage of the irrigational facilities can only be taken by reclaiming land, preparing the land for double-cropping and constructing communication channels for carrying water to the farms. For these purposes, long-term and medium-term loans will be needed, depending on factors such as the levels of required outlays and repaying capacity of the farmers, which depends upon the size of the farm and upon the nature of the investment involved.

There are in the country, certain areas, which are not adequately endowed in the matter of irrigation, etc. The exclusion of such areas and their inhabitants from the ambit of agricultural growth will have far-reaching socio-economic implications. Special efforts are,

therefore, needed to evolve appropriate technology to benefit these areas and to help them develop on the basis of such technology by providing them with the necessary facilities. Similarly, special arrangements have to be made for ensuring that the small farmers receive the required supplies and services.

It is difficult to quantify the requirements of agricultural credit in India. The extent to which the demand for agricultural credit will grow depends upon a number of factors such as the extent of the popularisation of the improved practices, the proportion of recommended dosages of inputs actually used by cultivators, easy accessibility of the needed inputs, and the capacity of cultivator to meet his cash outlays from his own financial resources.

According to the Fourth Five Year Plan, there has been, in recent years, a significant increase in institutionalising the rural credit, and over 30 per cent of the borrowings by cultivators are from institutional sources. A substantial step up in the Institutional credit will be necessary as the programmes of intensive agriculture, involving use of costly material and labour inputs, will require massive credit support. The All-India Rural Credit Review Committee (1969) has estimated the short-term credit requirements of agriculture at the end of the Fourth Plan at about Rs. 2,000 crores, out of which Rs. 827 crores is the estimated requirement for fertilizers, improved seeds and pesticides. The requirements of credit for capital investment in agriculture are also estimated to be of about the same order, consisting of Rs. 1,500 crores as the long-term credit and Rs. 500 crores as the medium-term credit.

The Rural Credit Review Committee has based its estimate on the estimates framed by the Planning Commission in connection with the Fourth Plan. The estimated short-term credit requirement of Rs. 2,000 crores includes the needs of High-yielding variety and non-High-yielding variety programmes and covers items like seeds, manures, fertilizers, hire of implements, cost of fuel and lubricants for mechanical cultivation, electricity charges for irrigation, etc. The medium-term credit requirements of Rs. 500 crores per year include purchase of livestock, medium-size implements and minor

irrigation. The break-up of the estimated long-term credit requirement of Rs. 1500 crores is as under :—

| | (Rs. crores) |
|---|---|
| (*i*) Minor irrigation | 725 |
| (*ii*) Reclamation of wastelands | 25 |
| (*iii*) Soil conservation programme | 150 |
| (*iv*) Heavy machinery and implements | 300 |
| (*v*) Orchards and plantations | 75 |
| (*vi*) Area Programmes | 125 |
| (*vii*) Rural Electification | 100 |
| | 1,500 |

It is, however, not enough to make overall estimates of requirements of agricultural credit. They have to be made for different states and regions and different sections of the agricultural community. Dry farming and irrigated farming, small farmer and big farmer, must have their respective needs for agricultural credit fulfilled. In other words, the all-India estimates of demand for agricultural credit will have to be broken down to state and district level and according to various types of agriculture and various sections of agricultural community. Even a satisfactory looking overall performance in the field of agricultural credit can very well conceal serious shortcomings in the meeting of the credit requirements of individual farmers.

The cooperatives have, so far, been the main institutional agency for the supply of agricultural credit. The volume of cooperative credit (short and medium term) increased from the level of Rs. 24 crores in 1951-52, to Rs. 490 crores in 1968-69. Long-term credit increased from Rs. 12 crores in 1960-61 to about Rs. 120 crores in 1968-69. Appreciable progress took place in cooperatively organised processing of agricultural produce mainly in the sector of sugar factories which account for about 1/3rd of the total sugar production. The value of agricultural inputs distributed by cooperatives rose from about Rs. 36 crores in 1960-61 to about Rs 250 crores in 1968-69. Of the inputs, the largest item consists of fertilisers and their value increased from about Rs. 28 crores in 1960-61

to about Rs. 250 crores in 1968 69, representing about 60% of the total consumption of fertilisers in the country. The proportion of borrowing of the cultivators from the cooperatives to total borrowings also went up from 3.1 per cent in 1951-52 to 15·5 per cent in 1961-62. The membership of societies increased from 48 lakhs in 1951-52 to 283 lakhs in 1967-68. The proportion of rural population (cultivating and non-cultivating) covered by membership had gone up to 33 per cent in 1968-69.

However, the expectations from the cooperative structure in regard to the meeting of the needs of agricultural credit could not be fulfilled. While, for the country as a whole, cooperative short and medium term credit nearly doubled during 1960-68, the progress towards development of a viable structure at the level of the primary credit societies and central cooperative banks remained below expectations. According to the Fourth Plan, two factors were responsible for this situation. First was the slow progress in the programme of organizing viable primary credit societies by the amalgamation of the non-viable societies and second was the increase in overdues. At the level of primary credit societies, the proportions of overdues to outstandings increased from 20 per cent in 1960-61 to 32 per cent in 1967-68 and to 42 per cent in 1968-69. For Central Cooperative Banks, the increase was from 12 4 per cent in 1960-61 to 25 per cent in 1967-68. Of the 344 Central Cooperative Banks, 67 accumulated overdues exceeding 50 per cent of the outstanding amounts.

Apart from the absolute short-fall in the supply of credit, the cooperative movement has been uneven in its development and lopsided in the distribution of available credit in the different regions of the country. The inadequacy of cooperative credit is particularly marked in the states of Assam, West Bengal, Bihar, Orissa, Rajasthan and Jammu & Kashmir. The bulk of the credit has been distributed in more advanced states of Maharashtra, Gujarat and, to some extent, Punjab. Even some of the advanced states like Tamilnadu, Andhra Pradesh and Mysore have slipped back. In Tamilnadu, the dormant membership has become a particularly acute phenomenon. There has been a pronounced increase in overdues even in the advanced states like Maharashtra. While seasonal

factors can explain this to some extent, the main cause for this has to be attributed to inefficient business management.

According to the FAO Report on the "New Approach to Agricultural Credit" the dynamic agricultural credit policy aims not so much at providing for the gap in the resources of the cultivator as to increase his productive capacity through which surplus incomes would be generated for being ploughed back into agriculture. This process did not become a built-in feature of the cooperative movement in India. While the new entrants in the field of agricultural credit, like commercial banks, have been able to mop up rural surpluses, the cooperative banks have failed in this regard. Some of the Central Banks have, through extensive branch banking, attracted a good number of deposits and are planning operations on a much wider scale in the rural areas.

The good performance of the cooperative institutions in the field of long-term credit is attributable to the non-existence in the country of any long-term cooperative credit structure. Now there is a well-established network of 19 land development banks and 719 primary land development banks, and also more than 600 branches of the central and primary land development banks. But, according to the Fourth Plan, the relatively undeveloped state of the land development banks in certain states has led to uneven levels of loaning to different states. This needs to be rectified by improving the structure of long-term cooperative credit in those states as also by persuading commercial banks to participate more in this context than they are doing at present. The Agricultural Refinance Corporation is expected to provide refinance of the order of Rs. 200 crores during the Fourth Plan period.

Despite the overall weaknesses of the Cooperatives, an important role was assigned to them in the Fourth Plan period. According to the Fourth Plan, cooperative short-term and medium-term credit will expand from the present level of Rs. 450 crores per annum to Rs. 750 crores in the final year of the Fourth Plan. As regards long-term credit, though the land development banks are considered well organised to handle loan operations of over Rs. 1,000 crores, a target of Rs. 700 crores only has been fixed for the plan period on the basis of the possible financial resources.

Considerable importance, no doubt, was given to the co-operatives in the Fourth Plan, they were, however, not relied upon exclusively for catering to the credit requirements of agriculture. In this context the following paragraph from the Fourth Plan is quite important and illustrative.

> "While, as in the past, cooperatives will have to be strengthened and treated as principal agency for agricultural credit, the approach in the Fourth Plan will be to ensure that agricultural **production is not inhibited by the weakness of cooperatives.** In areas where the cooperative credit structure is weak, there will be special efforts to provide alternative institutional sources. The policy in the Plan will be to institutionalise the agricultural credit to the maximum extent possible and to reduce direct loaning by government to the minimum. Among the alternative agencies will be agricultural credit corporations, to be set up under a law enacted by Parliament in states where co-operative credit structure is unequal to the task of providing adequate agricultural credit. The agro-industries corporations are also expected to finance investment through hire purchase of agricultural machinery and pumpsets."

In addition to the multi-agency approach described above, the Fourth Plan laid special emphasis on the role of commercial banks. In the words of the Fourth Plan : "for meeting the gap in agricultural credit, the potentialities of commercial banks have to be fully mobilised. Following social control, commercial banks had shown an increasing interest in the agricultural sector. The volume of direct agricultural finance outstanding from commercial banks increased from Rs. 5 crores during 1966-67 to Rs. 53 crores in 1968-69. In 1968, a consortium of commercial banks set up Agricultural Finance Corporation with the object of coordinating activities of the constituent banks and rendering them consultancy services. Consequent on nationalisation, it is expected that the nationalised banks will take further measures to increase their finances for agricultural production and investment. Certain steps have already been taken in this regard. Each district in the country has been allotted to one bank called the 'lead' bank. It is the duty of the lead bank to survey the resources and potential for banking development in that district and offer advice to small borrowers — farmers particularly — and assist the other primary lending agencies and maintain liaison with Government and quasi-Government agencies. The lead bank will also assume a major role in the development of banking in that district though it will not have a monopoly in the banking business in that district....Various scheduled banks are now embarking on a massive programme

of branch expansion with emphasis on unbanked towns or centres. This tempo will be kept up throughout the plan so that the banking facility is brought as near to the villager as possible. The banks will, thus, attempt to cater directly to the needs of the individual farmers. They are already setting up some mobile units to increase their coverage of villages from their existing branches. Direct lending to the farmer is expected to increase from Rs. 53·59 crores in June 1969 to Rs. 400 crores by the end of the Fourth Plan period.

The Fourth Plan also said : "The various institutional agencies catering to the requirements of rural credit will have to function in an integrated and coordinated manner. In view of the large variety of conditions, it will be necessary to make detailed plans for the development of credit and banking in the rural sector on the basis of local conditions. There is therefore, a need for an area approach on the basis of the district as the unit. This would mean the preparation of a credit plan for the district and integrating the plan with other developmental activities. Within this credit plan, the co-operative sector and the commercial banks will have to work in close coordination."

The above mentioned paragraphs from the Fourth Plan clearly indicated a radical change in the Government of India's policy in regard to institutional approach to agricultural credit. The approach evolved by the Rural Credit Society had relied mainly upon the co-operative banking structure, to meet all the requirements of agriculture credit The new approach evolved by Government, which has been supported by the Rural Credit Review Committee of the Reserve Bank of India, aims at a multi-agency approach to agricultural credit. In other words, to meet all the gaps and shortcomings — quantitative as well as qualitative on the agricultural credit front, other agencies also would now be called upon to supplement (not to supplant) the cooperative banking structure.

The Commercial banks had in the past, concentrated on trade, and later on, on industry, but had totally neglected agriculture. The State Bank of India had paid only limited attention to agricultural credit, though it helped the cooperative banking structure in having cheap remittance facilities through a network of branches in rural areas. Its agricultural finance covered only selective activities like plantations, agricultural marketing and processing and debentures of

land development banks. Its experiment with rural pilot centres made little headway. The insignificant contribution of the banking industry to the agriculture is indicated in the table below :—

**Borrowings from different agencies :**

All-India Rural Credit Survey (1951-52) : and
All India Rural Debt and Investment Survey (1961-62)

| *Agencies* | *Cultivators* | |
|---|---|---|
| | *AIRCS** | *AIRDS†* |
| | (*PERCENTAGES*) | |
| 1. Government | 3·3 | 2·6 |
| 2. Co-operatives | 3·1 | 15·5 |
| 3. Relatives | 14·2 | 8·8 |
| 4. Land-lords | 1·5 | 0·6 |
| 5. Agricultural Money lenders | 24·9 | 36·0 |
| 6. Professional Money lenders | 44·8 | 13 2 |
| 7. Traders & Commission Agents | 5·5 | 8·8 |
| 8. Commercial Banks | 0·9 | 0·6 |
| 9. Others | 1 8 | 13·9 |
| Total | 100 0 | 100 0 |

*All India Rural Credit Survey.

†All India Rural Debt and Investment Survey.

Following the social control, the commercial banks established agricultural credit departments and undertook a dynamic programme of agricultural credit.

The Agricultural Refinance Corporation, which acted like a consortium of commercial banks, was established in 1963. Up to the end of 1968-69, it sanctioned 233 schemes, involving a total outlay of Rs. 182 crores, of which the Corporation's commitment was Rs. 156 crores. Out of the 233 sanctioned schemes, as many as 125

related to minor irrigation. Lately, the Corporation made efforts to diversify the scope of its refinancing portfolio so as to include schemes for poultry, dairying, fisheries and even construction of storage accommodation. As a result, the Corporation's commitments rose from Rs. 156 crores at the end of 1968-69 to Rs. 215 crores by the end of June 1970.

The social control over commercial banks was introduced in December 1967. In February 1968 the National Credit Council (N.C.C.) was constituted. The council had decided that during 1968-69, commercial banks' credit to agriculture should increase by Rs. 35·40 crores over the level of June 1968. The target was more than fulfilled.

The N.C.C. went into oblivision after the nationalisation of the 14 major commercial banks on July 19, 1969. And, since over 4/5ths of the commercial banking system was under the direct control of the Government, the need for fixing credit targets was not felt.

The commercial banks' advances to agriculture increased rapidly after the nationalisation and by the end of December 1969 the outstanding agricultural advances reached the level of Rs. 258 crores as against 44·6 crores in June 1963. This may be seen from the table below :

**Table 1** Scheduled Commercial Banks' Advances to Agriculture

(*Rs. crores*)

| *Bank/Bank group* | *End-June 1968* | | *End-Dec. 1969* | |
|---|---|---|---|---|
| | *No. of accounts* | *Amount outstanding* | *No. of accounts* | *Amount outstanding* |
| 1. State Bank of India | 317 | 7 7 | 87,064 | 91·9 |
| 2. Subsidiaries of State Bank of India | 189 | 9·6 | 33,484 | 24·9 |
| 3. Nationalised Banks | 29,607 | 10·6 | 257,769 | 104·4 |

| | | | | |
|---|---|---|---|---|
| 4. Total of Public Sector Banks (1 to 3) | 30,113 | 27·9 | 378,317 | 221·2 |
| 5. Major banks in the Private Sector | 2,725 | 7·1 | 31,116 | 14·1 |
| 6. Other banks | 70,890 | 9·7 | 158,525 | 22·7 |
| 7. Total | 103,728 | 44·6 | 567,958 | 258·0 |

Source :—Reserve Bank of India Bulletin, June 1970

The assistance by the commercial banks has taken mainly three farms :

1. Provision of short and medium term loans directly to agriculturists for production and development purposes.
2. Providing credit facilities to the electricity boards, dealers in fertilisers and other inputs etc. which indirectly help the agricultural sector in increasing production ; and
3. Providing credit to farmers through the private credit societies in selected districts of the five States (four eastern states and Rajasthan where the cooperative movement has been weak).

The functioning of commercial banks in the rural areas created a new problem in so far as it posed a threat to the growth and existence of cooperative agencies there. The role of the commercial banks as a central financing agency for the primary cooperative societies is materially different from its role as one of the agencies directly providing the credit. The commercial bank branch has a strong backing and financial and administrative support from the large network of branches spread over a large part of the country. It can, therefore, offer better remittance and banking facilities. It also enjoys deposit insurance facility and has, at its command, personnel who are well trained in the art of banking. In view of all these factors, the efforts to build up a strong and efficient central co-operative bank may not receive the needed popular support and the public may even show a positive preference for the commercial bank branches functioning as a central financial agency.

With a view to bringing about close coordination between the

two institutional agencies, a national level consultative committee was set up towards the middle of 1968, which provided certain guidelines for more effective coordination, in order to avoid duplication or over-crediting of cultivators and to safeguard the functioning and growth of the cooperatives. The State level and even district level coordination committites were also set up in most of the states

The desired coordination, however, could not be achieved. At its meeting held in April, 1970, the National Level Consultative Committee (NLCC) received the complaints that the commercial banks were "snatching away" the farmer customers from the co-operatives and that the farmers who were listed as defaulters by the cooperatives were getting credits from the commercial banks. This state of affairs indicates that the coordination committees are most needed at the bottom and from this point of view, a closer liaison between the branch agent and the society secretary is the desideratum in the whole situation.

In some of the states, cooperative societies have not got reconciled to the idea of commercial banks functioning in the rural areas. For example, in Maharashtra, even the state level coordination committee has not been formed, probably because of this reason only.

The problem in regard to the main credit agency in the states where cooperatives are weak deserves special attention. It was proposed that the agricultural credit corporations be established in these states till such times as the cooperative banking is strengthened to take over as the main agency of agricultural credit. The central legislation enabling the establishment of such corporations was also passed.

It has become obvious that a logical corollary of multi-agency approach is credit planning, in the absence of which, different agencies in the field of agricultural credit are liable to tread on each others' toes. The National Credit Council recommended in this regard the 'district credit plan' to be jointly prepared by all the credit agencies in the district. Where the central co-operative bank is weak, the commercial bank will undertake the responsibility to

finance the primary co-operative credit societies and act as their lead bank.

The idea of 'lead bank' and 'credit planning', though commendable in theory, is beset with numerous difficulties of various types. The success for the credit policy of the Government of India depends on how far these difficulties are surmounted.

There is a contradiction in the efforts of the Government to encourage co-operatives on the one hand and the drive of the commercial banks for spreading into the hinterland of the rural areas. It looks likely that the Fourth Plan objective of encouraging co-operatives in the rural areas may be thwarted substantially mainly on account of the competition from the more efficient branches of the commercial banks.

## II. Agricultural Marketing

The development of marketing facilities for the agricultural produce is an important constituent of the agricultural infrastructure. The Fourth Plan says : "One of the key elements in the agricultural strategy of the Fourth Plan is to aim at improving agricultural marketing system in the interest of producer".

With the successful introduction of the High Yielding Varieties of seeds, the farmer has realized the importance of adopting new techniques of production and is looking forward to higher incomes and standards of life. The cropping pattern is, therefore, dictated by the profit motive which has brought the farmer face to face with market forces. Though the farmer is responsive to the market and understands the forces behind price mechanism, yet he is not conversant with the complexities of the marketing system which is becoming more and more complicated with the progress of time. While the trade is very well organised, the farmers are not. There are several malpractices in vogue in the markets which work against the interests of the farmer. He is made to pay high market charges and also several arbitrary deductions. Sometimes he does not even know the price offered for his produce. And then there is cheating

through under-weighing of his produce on account of the tacit understanding between the trader and the weighman.

For achieving the Fourth Plan target of agricultural production, it is important that the interests of the farmers are safeguarded and remunerative returns assured to them. For maintaining and sustaining the tempo of agricultural growth in the country, there have to be adequate and appropriate improvements in the field of marketing also. The pace of action in regard to the measures initiated in this regard in the past has, therefore, to be suitably accelerated and also new measures introduced.

The pressure on the marketing services is expected to increase with the increase in incomes and the standard of living of the people. The marketing system has, therefore, to be so developed that it is capable of carrying these additional loads adequately and equitably.

Expansion of the system of regulated markets constitutes the main programme of action for the development of the marketing infrastructure in India. Market charges in regulated markets are estimated to have been reduced by about 33 to 66 per cent and unauthorized deductions have been eliminated. Correct weighment, fair dealings and prompt payment are sought to be enforced through these regulated markets. Pace of regulation has, however, not been uniform in all the states. At the beginning of the Third Plan, legislation for establishment for such markets was in force in 9 States. Thereafter, 4 more States enacted the Agricultural Produce Markets Act. Thus, out of about 3200 principal markets in the country, only 1850 had been brought within the purview of the regulation by 1970. While some states like Maharashtra, Gujarat, Andhra Pradesh, Punjab and Haryana have made notable progress in regulation, progress in some other states is not encouraging. Some states, for example, Assam, Kerala, Jammu & Kashmir and Nagaland have yet to enact even the necessary legislation for the purpose. During the Fourth Plan period, the remaining states of Assam, Kerala and Jammu & Kashmir are expected to place the legislation on the Statute Book.

Besides bringing more and more markets under regulation, it is also necessary to improve the facilities in the regulated markets. In the words of the Fourth Plan :

> "Apart from covering more markets by regulation, it will be necessary to expand facilities by way of market yards and other ancillaries in various markets. A recent study has shown that in certain areas such as Punjab, during the post-harvest season of 1968-69, market arrivals increased by 150 per cent over the average of last three years' corresponding period. The capacity for market yards proved to be inadequate for these large arrivals and considerable market transactions began to be conducted outside the market yards, thus, leading to malpractices. In this context, efforts will be necessary for strengthening and restructuring market committees with regard to their resources and functions. A beginning has already been made by some market committees to obtain bank finance for improvement of marketing facilities. It will be necessary to enable a large number of market committees to resort to such institutional finance and, thereby, help in development of the market yards and in provision of ancillary services, such as market intelligence. Some of the well developed market committees are also expected to make their contribution to the development of feeder roads, for which a beginning has been made in a few rural areas. Finally, it will be necessary to evolve a suitable State level machinery for supervising and coordinating the work of regulated market committees. In this context, several states are contemplating action to constitute State Agricultural Marketing Boards on the lines of those functioning in Punjab and Haryana."

The Regulated Market Committees can play an important role for improving the marketing structure in the country. They can serve as focal points for initiation and development of programmes for the over-all development of agriculture in surrounding rural areas. The regulated markets can also earmark sites for shops which may stock different agricultural inputs like improved seeds, fertilizers, pesticides, etc. These shops may also stock pumping-sets and other small implements and machinery required by the farmers. Servicing facilities for agricultural machinery like tractors can be made available in or near the regulated markets. The sector reserved for shops can also stock consumer goods of different types. As a result, the farmers coming to the market for sale of their produce,

can also buy all their requirements for the farm and for their homes in the market itself and the shopping centres in the regulated markets can serve more or less the same purpose as the super-bazars in the urban areas.

An important aspect which has not yet received proper attention is the regulation of markets for fruits and vegetables and, more particularly, the terminal markets of Delhi, Calcutta, Bombay and Madras. As these markets receive supplies of fruits and vegetables, from practically all over the country and the trading practices in markets are far from satisfactory, their proper regulation is of utmost importance for enabling the growers of fruits and vegetables to realise reasonable prices for their produce.

In order to provide the required incentives to the farmer to improve the quality of his produce, it is necessary to ensure that he gets a price commensurate with the quality of his produce. For this, steps are required to be taken for introducing grading of the produce, before its sale by the farmer. At present, sales in the markets usually take place on the basis of visual evaluation of the quality by the buyers. The farmer seldom gets a price commensurate with the quality of the produce. Marketing surveys conducted by the Directorate of Marketing and Inspection have shown that the produce brought to the markets by the farmers usually contains a high percentage of refraction which could easily be reduced.

Grading on the basis of standards framed by the Directorate of Marketing and Inspection was introduced in some regulated markets and by cooperative marketing societies during the Third Five Year Plan period. The number of such markets, at present, is small. In the larger interest of the farmers, grading before sale, needs to be made more common, so as to cover all the assembling markets. Regulated markets can play a leading role in introducing this improvement by insisting that all the produce be graded before sale. Governmental and other agencies like the Food Corporation of India, Civil Supplies Departments in the States and the Apex Cooperative Marketing Organisations, which are engaged in buying operations for building up buffer stocks, can be of considerable help in popularising grading if they make purchases only on the basis of the grades prescribed by the Government.

Another significant programme for the improvenent of marketing system relates to the expansion of facilities for grading of agricultural produce. As the country is moving from an economy of shortages to that of surpluses, the consumer will, no longer, be satisfied with whatever quality is offered to him. He is bound to become quality-conscious and ask for quality goods. Certain articles of food like ghee, butter, edible oils, etc., are already being graded under Agmark. However, the quantities so graded, form only a small part of the total quantity marketed. Grading for the consumer, therefore, needs to be intensified. The Fourth Plan has also taken notice of the problem and says :

> "Despite some progress made in recent years, the overall share of grading in the total trade of agricultural produce still continues to be negligible, that is, around 1 per cent or so of the total value of the agricultural produce marketed. Hence, there is a very considerable scope for expansion of grading facilities. At present, there are about 450 grading units operated by various agencies, such as regulated markets, co-operative societies and central and state warehouses. In the Fourth Plan, a programme of another 600 grading units is envisaged. A pilot Centre for classing of lint with a view to helping the farmers in determination of the quality of lint and thus enabling them to market cotton in the form of lint, as against kapas at present, will be established at Surat. In addition, demonstration-cum-grading pilot units will also be taken up for certain agricultural commodities."

To facilitate agricultural exports, compulsory quality control and grading under Agmark, which is in operation in respect of 34 agricultural commodities, is proposed to be continued. In addition, pre-shipment inspection and quality control under Agmark is proposed to be extended to 10 new commodities. The laboratory facilities for testing the purity and quality of the produce, existing at Bombay, Cochin, Jamnagar and Madras, will also be further expanded. New laboratories are also proposed to be set up at Tuticorin, Mangalore and Alleppey during the Fourth Plan period. Another important scheme in the Fourth Plan relates to Central Agmark Research and Training Institute which will be set up to help in the adoption of technological improvements in the marketing of perishable products like fruits and vegetables. This institute will also undertake trial and demonstration of new equipment for cleaning, grading, packing, transport and storage and import training in the commercial use of new techniques.

### III. Storage and Warehousing

The existing storage space both in rural areas and in the markets is inadequate and unsatisfactory on the basis of total requirements as also from the point of view of preserving the quality and condition of the stored produce. This results in considerable losses on account of infestation with insects, seepage of moisture and loss on account of rodents, birds, etc. It is estimated that about 6 to 7 per cent of the total production of foodgrains is lost annually due to bad and insufficient storage capacity. Assuming the total production of foodgrains at 106 million tonnes and the estimated loss at only 6 per cent, the losses in terms of weight work out to about 6 million tonnes. In terms of money, it means a loss of about Rs. 500 crores every year. If this loss can be reduced even by 50 per cent, it would be a substantial saving.

A recent study of a group of 7 villages in Uttar Pradesh indicated nine types of storage structure in use as may be seen from the table below :

Storage Structures in Use on Farms in 7 Uttar Pradesh Villages.

| *Name of Structure* | *No. of villages in which found* | *No. of houses in which located* | *Capacities (Quintals)* | *Period of Storage (Months)* |
|---|---|---|---|---|
| Mud bin | 7 | 160 | 0·18 — 2·2 | 2 — 6 |
| Thekka | 4 | 26 | 2·6 — 3·2 | 2 — 8 |
| Kuthla | 6 | 38 | 1·5 — 4·5 | 4 — 6 |
| Tin Drum | 6 | 20 | 1·1 | 4 — 6 |
| Pucca Kothi | 5 | 8 | 7·2 — 22·4 | 4 — 6 |
| Kachha Kothi | 4 | 21 | 3·7 — 18·7 | 6 — 8 |
| Cement bin | 1 | 2 | 74·6 | 6 — 8 |
| Pucca Kotha | 1 | 5 | 44·8 | 6 — 10 |
| Jute bags | 7 | 310 | 0·95 | 2 — 6 |

Between 65 — 100% of these structures were insect-infested. All structures, except of tin and cement, were attacked by rats and a few of these showed signs of mould attack to the extent varying between 5-25%. Among these, the tin drum, pucca kothi, cement tank and pucca kotha are air-tight structures. The farmers, however continue to remove small quantities of foodgrains for their requirements often, and air-tight storage on the farm is, therefore, almost not possible. In other parts of the country, storage structures include bins made of split bamboo in addition to those observed in U.P. In some areas grain is kept as a loose heap in homes and in some, in underground khattis which are either dug-outs or concrete structures.

It has been observed that a sizeable increase in the production of wheat in Punjab has resulted in the produce being rushed to the markets in a short period of two months instead of normal 6—8 months taken earlier. This market behaviour is likely to spread to all parts of the country in the next few years as more areas are brought under High-yielding Variety (H.V.P.) programme. This sudden spurt in market arrivals creates conditions of pressure in respect of transport, labour and storage capacity. Creation of additional storage capacity to the required extent may not be feasible immediately, in view of the huge amounts of expenditure involved. In these circumstances, it would seem necessary to regulate market arrivals by holding grains on the farm. This may bring down costs of handling and storage by avoiding periods of peak pressures in the markets.

Storage techniques adopted on the farms heretofore, are neither adequate nor appropriate to meet the new situation. In a situation of demand exceeding supply, food standards could not be strictly adhered to. Low level of literacy and living standards further allowed tolerance of storage practices that were wasteful. To meet the challenge of the times, different structures, namely, plastic bins, rubberised fabric bins, butyl rubber containers, wire mesh silos, improved mud bins, concrete bins and bins of plain as well as corrugated steel sheets have been devised and tried in the country. The rubberised fabric bins are suitable for indoor storage. Concrete or corrugated steel bins, with arrangements for controlled

aeration are suitable for out-door storage. These structures are capable of being used for air-tight storage wherein no other treatment for protecting grain becomes necessary. But since, on the farm, some quantity will continue to be removed from storage at short intervals, insect control with fumigants is found to be necessary. Simple and cheap techniques for fumigation of grains on the farm (with the help of Ethylene dibromide and Aluminium phosphide) have been developed to meet this requirement. Extensive use of these two fumigation techniques has been made by farmers for the last five years with success in many parts of the country. It costs about Rs. 2 for fumigation of 10 quintals of grain costing more than Rs. 700. One fumigation keeps the grain free of damage by pests for a year or more.

Much of the storage capacity available for marketed surplus of foodgrains is suitable for storing of bagged grain and this is commonly known as conventional storage. Design for a structure that could be proof against rat, damp and white ant was developed after 1955. In these new godowns, the movement of grain-bags is rendered easy and there exists arrangements for controlling aeration. Public sector agencies and cooperatives have constructed godowns conforming to this standard design. Adoption of a standard design and providing rat and damp proof accommodation for foodgrains is estimated to have reduced the average commercial storage loss from 0·22—0·26% in early sixties to 0·1% in 1967-68 in regard to grain handled by the Central Government.

Silo is often recommended for scientific, loss-free storage of grain. This is above-ground storage in either steel or concrete bins. In India, similar storage was adopted in earlier years in underground structures known as Khattis. The first silo, comprising steel bins, was commissioned for storage of wheat in the country in 1959. Thereafter, silos, both of steel and concrete, have been set up at different locations and have been a success as far as maintenance of stocks over long durations is concerned. Initially, silo installation depended upon imports of all the parts, but now silos are being set up with local know-how and material. In order to ensure loss-free long storage and saving on jute bags, which are an important foreign exchange earner for the country, silo storage is essential. Silo

storage, however, involves greater amount of technology both in installation and operation in relation to conventional storage, and this, it is feared, is coming in the way of its rapid spread in spite of the fact that this technology is not lacking in the country. Of the modern storage capacity of around 6 million tonnes, about 0·4 million tonnes only is the silo type.

Loss in different types of storage described above can be considered in terms of physical and biochemical loss. Physical loss would be result of variation in moisture content, different methods of weighment, as also spillage and pilferage caused by rats and birds. Biochemical loss is caused by rats, birds insects and microbes. All types of physical and biochemical losses by rats and birds will be prevented when storage is mechanised and silo bins are used. Some estimates during post-harvesting handling are given in the table on next page.

The loss due to rats is estimated at 2·5% of the total production of foodgrains. On the farm, use of either steel, cement or rubberised fabric bins would prevent damage due to rats. Where storage is not made rat-proof, use of 'aluminium phosphide' tablets for burrowing rats and use of 'anti-coagulants' is the simple and effective step. Using this technique, a number of villages and towns in the country have been rendered free of rats during the last two years. On the basis of average consumption of 10 grams of food per day and large scale destruction brought about, one rat would cost the country about Rs. 10 annually. Rat-proof commercial storage structures involve an additional outlay of about Rs. 10 per ton which is a permanent remedy against rats. Pesticidal measures when carried out on a large scale mean an expenditure of Re. 0·07—0·09 per rat killed.

Loss caused by birds is estimated at 0·85% of the production. Damage occurs when grain is being sun-dried and is in storage. Use of mechanical driers and silo bins for storage is the main effective remedy against birds. A number of chemicals are said to be under test to repel birds from stored foodgrains, but decisive results are yet to be obtained.

About 35-40 types of insects are found in grain stores in India,

*Losses of Production in the years 1962-1965*

(*Percentages*)

| *Stages where loss is caused* | *Wheat* | *Rice* | *Jowar* | *Bajra* | *Maize* | *Gram* | *Millet* | *Pulses* | *Total* |
|---|---|---|---|---|---|---|---|---|---|
| Threshing Yard | 1·0 | 2·5 | 2·0 | 0·5 | 0·5 | 0·5 | 1 0 | 0·5 | 1·68 |
| Transport | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·15 |
| Processing | — | 2·0 | — | — | — | — | — | — | 0·92 |
| Storage | | | | | | | | | |
| Rodents | 2·5 | 2·5 | 2·5 | 2·5 | 2·5 | 2 5 | 2·5 | 2·5 | 2·50 |
| Birds | 0·5 | 1·0 | 1·0 | 1·0 | 0·5 | 0·5 | 2·0 | 0 5 | 0·85 |
| Insects | 3·0 | 2·0 | 2·0 | 1·0 | 3 0 | 5·0 | 0·5 | 5·0 | 2·55 |
| Moisture | 0·5 | 0·5 | 2·0 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·68 |
| Total | 8·0 | 11·0 | 10·0 | 6·0 | 7·5 | 9·5 | 7·0 | 9 5 | 9·38 |

but only 12 can be considered as serious pests. Some of these start attacking grain, even before it is harvested. Apart from eating away grains, insects leave behind their excreta, dead bodies comprising hard cuticle and pre-mature stages inside grain. These left-overs in the grain are capable of causing digestive disturbances. Damage caused by insect is, therefore, viewed with great seriousness in developed countries. In India, Pure Food Act (P.F.A.) lays down limit for insect damage in grain to be sold for human consumption. Insect damage is expected to be relatively more in high-yielding varieties, as these are soft and rich in protein.

The techniques developed for preventing insect damage are keeping moisture content in the grain low, air-tight storage and pesticidal measures. Control on moisture content and maintenance of air-tight conditions are possible in respect of bin or silo storage. On the farm, maintenance of either of the conditions is not possible because of frequent removal of grain. Capacity to the tune of 0·3 million tonnes is available in the country with the Food Corporation, wherein both the conditions are satisfied. Long storage for periods over two years, without leading to any deterioration, has been done in respect of commercial stocks in the country. Experience gained suggests that storage upto 5 years would be possible in this type of air-tight silo bins without deterioration and loss. The technique is now being extended by the Food Corporation in conventional godowns by keeping grain in loose bulks. Such loose storage of grain in conventional godowns would practically double the present available capacity for storage of wheat and would also render the storage practically free of losses.

Pesticidal measures adopted in the country comprise fumigation with either Ethylene dibromide or Aluminium phosphide for the farm storage and with either Methyl bromide, Ethylene dibromide or Aluminium phosphide for commercial storage. Surface treatment with Pyrethrum, Malathion or Dichlorovos is carried out in commercial storage in addition to fumigation. Extension and training programmes undertaken in the country during the last few years have made fumigation of grain on the farms popular. The treatment is specially rendered simple and cheap for this purpose by

developing of fumigant ampules by Indian scientists that can be safely used by agriculturists. Commercial stocks held in storage by Governments, corporations and some cooperatives are treated with abovementioned pesticides as a routine measure. It is estimated that about 10 million tonnes of stocks receive such treatments annually. The required pesticides had to be all imported till 1964, but now all the pesticide requirements for stored foodgrains can be met from Indian production. Average cost of pesticidal treatment for grain to be held in storage for a year amounts to Rs. 2 per ton.

Microbes are always present on the grain. They become active only when grain moisture is high and temperature is favourable for their development. Some of these are known to produce toxine as a result of their activity. Aflatoxin, when present as a result of activity of *Aspergillus flavous* is now known to be responsible for the death of poultry and for producing cancer in animals. Discolouration for appearance and bad smell produced in grain during storage are results of the activity of microbes. It is realised all over the world that development of microbes results in undesirable effects being left behind, full significance of which is yet to be learnt. Only methods known for preventing microbial damage are keeping the grain cool and dry. Air-tight storage is also known to prevent microbial development. Sun and mechanical drying of grain having high moisture content is being done in India to prevent microbial damage to grain. Sun drying, which results in pilferage by birds and rodents, and is also a labour-intensive programme, is being replaced with either mechanical drying or drying by applying common salt. According to available experience, grain having moisture lower than 14% is safe for storage in bags and less than 13 per cent for storage in silos.

Microbial damage is significant in Indian conditions when grain bags are placed on the floors without any dunnage. This damage is brought about either because of the seepage of soil water or moisture of the grain condensing on the cool cement floor. Polythene sheets used as dunnage, prevent this damage completely.

The basic question needing consideration in respect of storage from the point of view of avoiding losses is as to what extent it should

be mechanised and whether the stress should be on centralised storage or on distributed storage on the farms ? Mechanised storage or, in other words, bulk storage, occupies less space and is most efficient in preventing loss; but its adoption needs a complete change in the present pattern of marketing, assessment of quality, transport and maintenance. At every stage, more technology but less manual labour is involved and resistance from traditional agencies will have to be countered. A silo with all accessories, costs in India around **Rs. 250/- per ton. Conventional godowns, wherein all operations** are labour-intensive, cost Rs. 10-20 less per ton. For storage in the godowns, grain is to be bagged. The cost of bags comes to Rs. 30 per ton, and the space required is about double.

Centralised storage by a few agencies like Food Corporation and warehousing corporations would be desirable from the point of view of maintaining controls over deterioration of quality. Cost of storage structures to be put up by these agencies amounts to Rs. 250/- per ton and average cost of maintenance in storage is around Rs. 2·50/- per ton per month. From the point of view of assuming a commanding position for supply of food at a reasonable price, it may be desirable to hold certain quantities with centralised agencies. It may prove expensive to plan for such a capacity beyond the required level. Storage on the farm, though scattered, would prove economical, as the cost of maintenance would be less than Re. 1·00 per ton. For a loss-free storage on the farms, steps will have to be devised to promote scientific storage, fabrication of steel bins for the agriculturists at low costs and availability of credit and incentive for storage.

Mechanisation of commercial storage and adoption of scientific storage on the farm will necessitate gearing up of activity for designing and fabricating silo bins of different capacities, and cleaning, weighing and conveying equipment. Pesticides produced in the country presently are sufficient to cover the need of 10 million tonnes of stocks only. Storage on the farms would, in addition, need efficient control of rats. It seems desirable in this connection to promote pest control through competent pest control agencies by providing incentives in the beginning, and, later, making the programme self-supporting. This will ensure use of pesticides by trained and

competent personnel, thereby avoiding subsequent consumer hazards, and wide coverage in a shorter time. Export of foodgrains would be possible only when quality standards are scrupulously maintained and pest control is efficiently managed.

In the Fourth Plan, it is proposed to train the traders, millers and cooperatives in scientific methods of foodgrains storage and to popularise cheap and effective pest control techniques. A country-wide 'Save Grain Campaign' was launched in 1965 by the Government of India for the propagation of cheap and effective methods of insect and rodent control among various private agencies storing foodgrains for consumption, seed and sale purposes. Steps were taken to amend Wheat Roller Flour Mills (Licensing and Control) Order, to provide for better storage in the roller flour mills. State Governments were also requested by the Government of India to make suitable amendments in the relevant Foodgrains Dealers' Licensing Orders, to make it obligatory on the part of the traders to undertake suitable measures for the avoidance of wastage of foodgrains while in storage. Most of the States have already made the necessary amendments. It is proposed to effect the necessary legal change in the remaining states during the Fourth Plan period.

Research and training are essential for the development of scientific storage. These activities are being undertaken by a number of organisations such as the Indian Grain Storage Centre, Hapur, and the Central Food Technological Research Institute, Mysore. Specific area in which research and training are proposed to be strengthened, relate to the requirements of material for storage construction, its cost and management. The Central Warehousing Corporation has introduced extension services for the promotion of scientific storage among stockists of agricultural produce in the private sector. It is proposed to extend this activity through the State Warehousing Corporations.

The introduction of metal storage bins has been a development of some promise. A pilot scheme has been taken up by the Government for this purpose. Under this scheme, metal bins will be supplied to the farmers on instalment basis, and they will be rendered technical help

for installation and maintenance of such bins. Apart from this pilot scheme, in certain areas, such as Punjab, over 10,000 metal storage bins have been introduced at the farm level, largely at the initiative of the farmers themselves. It will be necessary to review the operation of these bins before the programme is taken up on large scale.

The Fourth Plan programme of storage is based on an integrated view of the requirements of storage for various purposes, namely, storage of buffer stocks and operational stocks of foodgrains by the Food Corporation of India, provision of warehousing facilities for the producers and the trade, the Central and State Warehousing Corporations, and the requirements of storage facilities on the part of cooperatives for both the distribution of agricultural inputs and the marketing of agricultural produce.

On the eve of the Fourth Plan, the storage capacity was as under :—

**Storage Capacity : 1968-69**

**(million tonnes).**

| *Sl. No.* | *Agency* | *Owned* | *Hired* | *Total* |
|---|---|---|---|---|
| | *(1)* | *(2)* | *(3)* | *(4)* |
| 1. | Food Department and Food Corporation of India. | 2·62 | 1·26 | 3·88 |
| 2. | State Governments | 1·40 | 1·26 | 2·66 |
| 3. | Central Warehousing Corporation | 0·65 | 0·31 | 0·96 |
| 4. | State Warehousing Corpns. | 0·23 | 0·60 | 0·83 |
| 5. | Cooperatives | 2·60 | —— | 2·60 |
| 6. | Total | 7·50 | 3·43 | 10·93 |

For storing foodgrains, the total owned capacity at the beginning of the Fourth Plan was nearly 4·51 million tonnes. The effective storage capacity available after providing for operational purposes works out to 4·0 million tonnes. A part of this capacity was

to be utilised for storage of operational stocks. About 1·5 million tonnes could be deemed to be available for storage of buffer stocks. On this basis, an additional effective capacity of 3·4 million tonnes was necessary to provide for a buffer stock of 5 million tonnes.

With regard to the expansion of warehousing facilities, the Fourth Plan contains an outlay of Rs. 12 crores for the Central Warehousing Corporation. A part of this outlay will be utilised by the Corporation for contributing to the equity capital of State Warehousing Corporations. In addition, State Plans include a provision of about Rs. 6 crores for State Warehousing Corporations. It is envisaged that the additional capacity to be put up by the Central and State Warehousing Corporations will be of the order of 1 million tonnes. In the cooperative sector, the programme of construction of storage has so far been financed entirely by the Plan funds. In the Fourth Plan, the cooperatives will have recourse to banks with refinancing facilities from the Agricultural Refinance Corporation. On this basis, the provision made under the State Plans for co-operative storage is intended to be used essentially as margin money. Cooperatives are expected to establish about 2 million tonnes of additional storage capacity during the Fourth Plan period.

## IV. Research

Research being the basis for all technological advances, constitutes an important part of the infrastructure for agricultural growth. The Fourth Plan says : "Application of science and technology to agriculture being the key note of the strategy for the Fourth Plan, agricultural research has been accorded an important place in the Plan".

In India, research requires to be done in the several various fields of agriculture. There are separate research requirements of the irrigated and the rainfed areas of the country. And then special attention has to be paid to the problems of small farmers in the irrigated as well as rain-fed areas of the country. Introduction and popularisation of multiple cropping is also throwing up problems which require speedy solution.

In the irrigated areas, cultivation of newly evolved high-yielding varieties is creating enough problems for the scientists. Though advances in genetics have made it possible to 'design' plants to suit our present day requirements, it is yet only a beginning of the phase of purposeful genetic engineering and artificial transmutation of genes. Recent advances in plant physiology promise to open up further vistas in crop improvement. Even the little done in crops other than cereals and millet is a sufficient pointer to the great promises in this regard. For example, both quicker yielding and higher yielding strains of pulses like 'moong' and 'arhar' and oilseeds like 'Sarson' are now undergoing multiplication. Similarly, new varieties of castor and cotton of much shorter duration have been developed. A very large range of material is now available to the modern plant breeder and it is time that India participates in such work actively, keeping in view her own requirements in respect of certain economic plants. This has to be done, before India's magnificent range of basic material is discarded, and destroyed, after the interested countries have got their "pick and choose" from the lot.

The potentialities of the H.Y.V. programme for raising foodgrains production will have been more or less fully exhausted by the end of the Fourth Plan period, because the irrigated areas suitable for the H.Y.V. programme are very much limited in the country — forming only about 1/5th of the net cropped area. The emphasis will, therefore, have to be shifted to the development of agriculture in the rain-fed areas, with a view to realising a balanced growth of agriculture in the country.

Consideration of 'quality' will have to be given a greater attention in the future evolution of varieties. In fibre crops, jute and cotton, varieties of much better strength and fineness of fibre may become available. In rice, varieties with not only higher protein content but also a better distribution of proteins in the grain (thereby minimising the loss of protein during milling), are needed.

Besides noteworthy improvements in the existing crop plants, new ones are likely to become increasingly important. Soybean has just gained a foothold and both this and sugarbeet can be expected to

enter the cropping pattern in suitable areas. The man-made cereal "Triticale" created by crossing wheat and rye, is already giving indications of being worthy of production in the future.

In order to get more and more return from less and less land, a constant improvement in the efficiency of farming has to be brought about. This would necessitate more attention to the qualitative aspects of input use and also to the many problems of post-harvest technology. Future research will attempt to standardise techniques of increasing the return from the land from all inputs, whether water or fertilizer, and of improving the efficiency of energy, whether human, animal or solar.

Through proper planning, based on scientific advances, some of the unfavourable consequences of intensive agriculture should be anticipated and remedial action taken to prevent large scale crop failures. Already some serious soil-fertility problems, for instance in respect of some micro-nutrients, are developing in intensively-cropped areas like Punjab. These will have to be given full attention, on a priority basis. Facilities for testing soils will have to be considerably expanded.

In the seventies, a greater use of the latest research tools will be made in accelerating the pace of the agricultural revolution. For example, the use of "remote-sensing" techniques like infra-red aerial photography will be developed for detecting diseases and to assess soil characteristics. A beginning has already been made in this technique for studying the coconut root wilt disease in Kerala. When conditions for the growth of plant improve, conditions for the multiplication and spread of pests and pathogenes also get better. It is, therefore, essential not only to devise control measures, but to develop warning systems of disease and pest outbreaks, at least in the major crops, so that the available control measures can be applied, in time, to prevent heavy losses. This requires a greater understanding of ecology in relation to the multiplication of pest and pathogenes, than is currently found. In this endeavour "agricultural meteorologists" will play an important role.

Crop planning on a regional basis is extremely important. For

example, the scientific ingredients for making a major advance in rice production are now available, and, under suitable conditions, India can possibly produce additional 10 million tonnes of rice from the present area within the next five years. The consequences of such an increase in problems like storage, transport, marketing and pricing would have to be studied in advance and suitable action initiated. There has also been a re-assessment of the export potential of flowers, fruits and other non-traditional agricultural commodities, and it is obvious that there are great opportunities to be availed of in this direction. However, the quality requirements in the export markets require to be studied and detailed specifications drawn up. This would enable scientists to 'tailor' strains answering specifications. The choicest Indian mangoes, the better varieties of bananas and new varieties of potato and tapioca, if grown on an extensive scale, would help to develop good export markets, in addition to contributing to the elimination of caloric shortages.

The rain-fed areas have their own problems. It is imperative that needed research in this regard be intensified at the earliest possible. The ingredients of the technology for these areas are as under :—

(*i*) Land consolidation and soil conservation ;

(*ii*) Improvements in tillage, leading to better soil structure and root penetration ;

(*iii*) Addition of organic matter in the form of plant-residues with a view to improving the physical and biological characteristics of the soil ;

(*iv*) Adoption of water harvesting procedures ;

(*v*) Addition of plant nutrients through deep placement of fertilizers and foliar-feeding ;

(*vi*) Improving of biological fixation of nitrogen through use of efficient strains of rhizobia, particularly those tolerant to salt ;

(*vii*) Introduction of photo-insensitive and quick-maturing crops which are less affected by drought ;

(*viii*) Development of appropriate single, double and mixed crop rotations ;

(*ix*) Popularisation of crops like soybean, high protein maize, macaroni wheat, short duration varieties of castor and cotton and perennial crops like cashewnut, oil-palm and date-palm, which can form the base for small scale food industries and export earnings ;

(*x*) Popularisation of grasses like lemon-grass, panicum, cenchrus and high protein bajra ;

(*xi*) Genetic upgrading of the non-descript cattle population by extensive programme of artificial insemination with semen from tested bulls of superior breeds.

While the above would constitute the major elements of an immediate action plan of research for the rain-fed areas, a systematic survey and development of ground water resources is essential for reducing the effects of weather on cropping and for raising the income potential of farmers.

Multiple cropping programme has been given a special significance in the Fourth Plan. The cropping intensity in India is only 118 per cent as against 180 per cent in Taiwan. The success of the Multiple Cropping Programme depends mainly on the evolution of suitable short duration varieties of crops and the selection of various crop rotations according to the varying climatic requirements of different areas in the country.

Several measures have been taken by the Government of India for the promotion and diversification of research efforts in the country. The Indian Council of Agricultural Research which is the apex organisation for sponsoring, coordinating and directing agricultural research and education in the country, has been reorganised in recent years. Since 1965, steps have been taken to place all the Central research institutions and those under the Commodity Committees research institutions, under I C.A.R. The Council has now 25 research institutes, research stations, and eight soil conservation research and training centres under it. In the Fourth Plan, the Council is proposed to be further strengthened and placed in possession of adequate funds. A sum of Rs. 85 crores has been provided in the Central sector of the Plan for agricultural research and education.

It is quite probable that the principal agencies involved in the research programmes in future, will be the Central research institutes, agricultural universities and, to a limited extent, research stations run by agricultural departments in some states. From the point of view of organisation of agricultural research, care will be necessary to ensure that there is no overlapping of effort or proliferation of institutions. Existing research sub-Stations will, as far as possible, be tied up with agricultural universities where these have been established. No new central research institutes should ordinarily be sought to be set up in the jurisdiction of agricultural universities. Similarly, in states which have already set up agricultural universities, it will be necessary to ensure, that, apart from teaching, research is also transferred to the university from the state Department of Agriculture.

An important feature of agricultural research in the Fourth Plan period is the all-India coordinated research projects. These call for a multi-disciplinary approach as well as inter-institutional cooperation. Plant breeders, geneticists, agronomists, agricultural chemists and plant protection scientists are required to work in close collaboration, so as to ensure that the disciplines have a combined impact. Each project envisages research scientists in the central and state institutes and agricultural universities, working as a team with a project co-ordinator, appointed by I.C.A.R., acting as a research leader fostering cooperation and coordination of research carried out by various participating institutions. The system also provides a built-in mechanism for continuous assessment of achievements and impediments in the form of an annual workshop, attended by participating scientists.

The idea of a coordinated research project was tried out as early as 1957, when a coordinated maize breeding scheme was initiated. Since 1965, a systematic effort has been made to formulate other coordinated projects. On the eve of the Fourth Plan, 38 projects had been sanctioned and 32 projects were in operation. These projects will necessarily spill over to the Fourth Plan. In addition, it is contemplated to take up 44 new all-India coordinated research projects. A total provision of Rs. 34·70 crores has been

included in the Fourth Plan by way of spill-over as well as for new projects.

The Fourth Plan says :

"Research on pulses did not get enough emphasis in the past. This will be undertaken for the special benefit of the rainfed areas. Emphasis will be laid on research in dry farming. Research will also be directed to the problems of plant protection consequent on the use of the high yielding varieties. Widespread use of the new varieties will bring with it a new order of demands on account of depletion of various nutrients in the soil. Problems connected with the soil structure, including that of maintenance and the continued ability to produce high-yields will call for wide-ranging research on the use of plant harmones as well as the study of soil and crop chemistry. Research will have to be harnessed to problems of post-harvest technology such as threshing, drying, storage and processing.....

A panel on irrigated farming was set up recently to review, in the light of long-term scientific and technological considerations, the programmes which are already in operation, and to identify the main areas in which further research or investigation is needed for the formulation of long-term policies in regard to different aspects of farming in irrigated and rainfed areas. The panel has made a number of recommendations. Among the problems dealt with are those pertaining to humid areas such as Kerala, Assam, Tripura and Nagaland. The Panel has suggested work on breeding of varieties which can be harvested before incidence of floods, which are a recurring feature in some of the areas of North-East India. Another identified problem area relates to eight million hectares of land which are inundated by sea water. The development of techniques for the use of sea water as well as the assessment of economics of the use of de-salinated water need to be studied in this context. These and other aspects indicated by the Panel have been taken cognizance of and requisite funds provided in the Plan.....

One significant area of research will relate to soil, plant and water relationship. Studies already made, reveal a high response to correct timing of water application. There is considerable room for further studies of plant evaporation/transpiration ratios and the economies of improved water management. Other connected fields of research are problems of reconciling agricultural needs and engineering practices. Among the important developments envisaged are the establishment of a water technology centre at I.A R I. and a Central Soil Salinity Research Institute at Karnal.

In the sphere of agricultural education, the nine agricultural universities already set up will be strengthened. Some of these universities have started making notable contributions to agricultural education and research. A number of them, however, continue to suffer from inadequate facilities. In the Fourth Plan, efforts will be made to rectify these deficiencies. In addition, six new universities are likely to be established. A sum of Rs. 21·5 crores has been allocated in the Fourth Plan to enable I.C.A.R. to assist agricultural universities in regard to specified developmental items. For the balance, it is contemplated that the agricultural universities will be assisted by the concerned states from the State Plans.....

During the Fourth Plan period, while funds have been allocated to agricultural universities as also for strengthening post-graduate and under-graduate colleges, it will be necessary to ensure that educational planning broadly conforms to the likely demand for trained agricultural manpower. This caution has become essential in view of the fact that, in recent years, there has been a large expansion in the number of agricultural veterinary and agricultural engineering colleges with the result that, in respect of certain categories, such as agricultural engineers and veterinaries, the supply has outstripped available demand. In order to make optimal use of existing facilities, it is contemplated that I.C.A.R. will take requisite measures so as to ensure maximum inter-institutional cooperation and avoidance of additions to underutilised capacity. Steps would have to be taken to improve the standard of agricultural colleges that have mushroomed in some states. In certain cases, such colleges may be converted into farmers' training institutions. Where it is not feasible to take such remedial measures, these may have to be closed down."

In the middle of 1971, there were 15 agricultural universities working in India. With the growing needs of the developing economy, therefore, the strength and vigour with which these universities proceed and develop their capacity and capability to rescue the posterity of the emerging problems, will determine the future course of economic, social and political events.

In general, the investment on agricultural research will have to be increased at a higher and higher rate. The traditional agriculture has been maintaining a low level productivity equilibrium, independent of research input. The productivity levels of modern agriculture would, however, fall headlong if agricultural research gets slowed down. Hence these institutions will have to be vigilant to

anticipate the future problems and be prepared to find solutions for them.

The continuous success of production technology will depend much upon the availability of variable factors of production such as fertilizers, water, insecticides, pesticides etc. Water would turn out to be a most crucial input. The availability and efficiency of water use will ultimately determine the level of food supply and production of other agricultural products available per capita. The lack of water rather than of land, will be a limiting factor for the food production in the future. Thus, in future, the emphasis is likely to shift from man-land ratio to man-water ratio.

In the wake of the green revolution, the problem of widening gaps in the distribution of incomes among the various classes of peasants, land owners, tenants and labourers will acquire new dimensions. The differentials in the income growth and widening of gaps in the income levels of various rural classes will very likely lead to some serious social and political dissatisfactions and discontents. Only well considered, wise and unconventional scientific policies can ward off such social discontent. Another equally important problem will be that the labour force explosion and the *food population* problem of the sixties will turn into *employment population* problem of the seventies. These universities will have to increasingly concentrate on research on these issues for practical advisement on these and such other important economic and social problems of future India.

With the fast increasing role and participation of agricultural universities in the process of economic development of the country, the extension services of the universities will come under heavy pressures to cope with the needs of maintaining a continuous and close rapport between the universities and the farmers in order to translate the results of the research into practice and keep the universities informed of the latest field problems. The universities will need to be prepared to take up and shoulder the increasing responsibilities in extension education and departments of the Government will have to revert to their rightful assignment of regulatory activities in the field of agriculture.

With the gradual increase in the scope of activities of the agricultural universities, there may arise a shortage of the really competent and well trained personnel. This imbalanced demand and supply position of trained persons is likely to create serious stress and strain on the better equipped universities as there will be continuous drain on experts from these universities to the new universities, which might be providing better job opportunities. In order to meet the future increased demand for the highly trained and competent scientists and teachers, the universities need to gear up their instructional programme in respect of quality and standards. Otherwise, there is real danger that a vicious circle of low-competence teachers producing low-standard graduates will start operating.

### V. Farmers' Education and Training

A successful implementation of The New Strategy is not possible without a comprehensive and dynamic programme for the education and training of the farmers in the country. A speedy and extensive introduction of technological change by the Indian farmers is a *sine qua non* for bringing about the desired increase in agricultural productivity in India.

Technolcgical change can be broadly defined as a change in the parameters of a production function, resulting directly from the use of new knowledge. In simple words, technological change means a shift in the production functions involving adoption of those farming techniques which are developed through research and are calculated to bring about diversification and increase of production with a view to increasing economic returns of the farmer. Use of fertilizers, pesticides, improved seeds and improved implements, contour bunding as a soil conservation measure and introduction of irrigational facilities in new areas, constitute important technological changes. The three essential pre-requisites for bringing about technological changes are :—

1. Improving the quality of agricultural inputs ;
2. Organising their supply at reasonable prices ; and
3. Educating the farmers about their efficient use.

Income, size of operational holding and literacy are some of

the factors which determine the pace of diffursion of technological changes in any group of farmers. The diffusion of an innovation in agriculture has three stages :

1. A gradual, cautious and slow adoption ;
2. A comparatively quicker pace of adoption ; and
3. The usual "levelling up" of the rate and extent of adoption.

The programme for the education and training of farmers should be comprehensive, sound and dynamic. It should identify the problems of each particular area, devise suitable scientific remedial measures to tackle them and also educate and encourage the farmers in regard to the use of the remedial measures so evolved. Problems of a particular area may change with time and changes in the climatic conditions, or, even due to the introduction of technological changes in that area. This will require, every time, fresh efforts for the evolving of remedial measures and their popularisation. In fact, for a proper development of agriculture in the country, each farmer has to be observed and guided from time to time. The 50 million farms in the country, thus, constitute 50 million perpetual problems, for tackling which, the programme for education and training of the farmers has to be well equipped.

The launching of the High-yielding Varieties Programme under The New Strategy, provided a well-defined objective and purpose for the programme for the training and education of farmers in India. The yield in the case of wheat which used to be about 10 to 15 maunds per acre with the best indigenous varieties, was raised to fifty maunds per acre with the new seeds, but with the same improved practices that were being recommended in the past. The prospects of this sharp increase in yield and income, provided a strong motivation for seeking the skills required for using the new seeds and participating in the new programme. The skills are continuously being improved upon by the research scientists, and the fast pace of change in technology not only makes training imperative, but also needs, on the part of those responsible for training, a constant alertness and awareness about the newly evolved methods of

production. Training, thus, becomes a direct response to a production process and also seeks to promote a climate conducive to the realisation of the optimum economic gains from that process.

There exists in India, a rather compelling situation for accelerating the pace of the programme for farmers' training and education. Bigger and more resourceful farmers have a better access to the skills necessary for the adoption of new technology, as against the small farmers. In the first four years of high yielding varieties programme, when multiplication of the new varieties of seeds brought in exhorbitant profits, a number of resourceful farmers obtained information, skills and necessary inputs from all kinds of sources, and at fancy prices. But when the first stage of adoption of new seeds was over, the pace of the progress indicated signs of deceleration. The reason was obvious : the farmers who were yet to take to new seeds, were small farmers, who, despite having sufficient motivation for the HVP programme had no access to new techniques and inputs. In these circumstances, the importance of the farmers' training programme acquires added significance.

A Centrally sponsored programme titled 'Farmers Training and Education Scheme' was initiated in 1966-67 in the country, in order to meet the education and training needs of farmers in High Yielding Varieties Programme area. The intention was to try out arrangements for intensive training and dissemination of useful information in selected districts. Being a new Project, only five districts were covered during the year 1966-67. Later on, the scheme was extended and the number of farmers' training centres rose to 25 in 1967-68 and to 50 in 1968-69. A revised scheme was put into effect during 1970-71 and the number of districts covered by the scheme rose to 80.

The Fourth Plan, includes a programme of national demonstration which envisages organisation of demonstrations in 100 selected High Yielding Varieties Programme districts at the rate of 15 per district. These demonstrations are to be carried out in each district under a team of four Subject Matter Specialists in soil, agronomy, plant protection and agricultural engineering and will

seek to establish the production potential of each unit area of land through multiple cropping supported by a package of improved practices. There will also be a second line of demonstration to be conducted by the State Agricultural Extension personnel. Other components of the Farmers' education programme in the Fourth Plan relate to dissemination of agricultural information through audio-visual aids and formation of farmers' discussion groups. The programme relating to exchange of farmers is also proposed to be enlarged.

The Centrally sponsored programme of farmers' education and training consists of three main components :

1. Farmers' training
2. Farm broadcasting ; and
3. Functional literacy.

**1. Farmers' Training**

The farmers training programme comprises the following elements :

(*a*) *National and Other Demonstrations.* Demonstrations organised on farmers' fields corstitute the focal point of farmers' education programme. In each district there are proposed to be about 15 National demonstrations conducted by the Specialists covering all important crops of the area, in rotation. But, since these demonstrations may not be adequate for the total needs of the district, it is also proposed to take advantage of the scientific demonstrations conducted by the State Governments, input suppliers and voluntary organisations in the district. Farmers within a walking/cycling distance are to participate in these demonstrations at the time of important crop operations. The date, time and venue of operations to be carried out are proposed to be announced in advance, through the radio.

(*b*) *Peripatetic Training.* In order to link up organised demonstrations and supporting follow-up efforts, there is provision in each district for a peripatetic team of trained and experienced field personnel, having at its disposal a specially designed and fully equipped audio-visual-cum exhibition van for holding training camps on use

of high yielding varieties of crops. The farmers from local and neighbouring villages are invited to participate in these training camps. It provides the necessary extension support to the national demonstrations and other field demonstrations in the district. In the training camps for farm women, particular stress is laid on matters relating to consumer education on high-yielding varieties of cereals, seed selection, domestic storage of foodgrains etc.

(*c*) ***Specialised subject-matter training courses for farmers.*** Rapid advances in modern agricultural technology have highlighted the need for training in some specialised areas also. These needs are to be met through specific subject-matter training courses conducted at agricultural colleges, research stations, farmers' training centres etc., where expertise and physical facilities are available.

(*d*) *Farmers' Discussion Groups.* The Farmers' Discussion Groups are organised in the villages to serve as a continuing medium for the dissemination of the latest information on farm and home development and for encouraging the adoption of improved practices through group discussions and group decisions. These groups are closely linked with the demonstrations and provided with low-cost transistorised and radio sets at subsidised rates with a view to facilitating listening of the bi-weekly broadcasts. The listening groups are to establish a two-way communication channel between the farmers on the one hand and the specialists and radio on the other.

(*e*) *Conducted Tour of Farmers.* In the context of the fast moving developments in agriculture, where extensive areas are being brought under high-yielding varieties and multiple cropping programmes and farmers are evincing keen interest to see progressive farms and exchange views with fellow farmers on current programmes and field problems, the government proposes to provide farmers with opportunities to visit other progressive farms and agricultural institutions such as agricultural universities, research stations etc.

The main objective of the Farmers' Training programme should be to provide instructions to the primary producers in the various fields of the production process. In order to be effective, the training programme should cover the various production

operations, should be conducted on the field itself and should also have a bearing upon the use and availability of various inputs.

The training process should correspond to the various stages of the production operations. The training will have to have a time-table corresponding to each stage of the crop, beginning from the preparation of land to the harvesting, and even its marketing. The 'syllabus' must give due importance to the various phases of the production process, *e g.* irrigation, top-dressing, plant protection, foliar spraying etc.

It is essential to have the training on the farmers' fields because it is primarily intended for the benefit of the farmers. Instructions by word of mouth or printed word or through modern aids should follow demonstration on farmers' field rather than precede them. Having the training programme on the field and, thereby, turning the field into the 'class room' has the additional advantage of doing away with the compulsion of the actual worker to be away from his place of work for long periods of time, as becomes unavoidable in the case of most of the campus-based training programmes. The demonstration should be on those private farms only which happen to be situated within an easy access of the largest number of farmers participating in the training programme.

The training should have a bearing upon the use and availability of inputs required for the new technology of the specific programme. The instructor should not merely be a theoretical teacher, but should be capable of giving al o the practical tips for getting over the common difficulties of the farmer. The educator has to be somewhat involved, though not directly, in the supply and arrangements of inputs *viz.* chemical fertilizers, machinery, plant protection material, irrigation, credit, etc. He has to have a more up-to-date knowledge of what is happening around. It means also that supply and arrangement of inputs for crops etc. should. where possible, be made the occasions for the communication of information and techniques to the farmers.

Demonstrations in government seed-farms and in research laboratories have been an old practice and did not carry conviction.

Demonstrations on the farmers' fields by extension officers marked an improvement over the earlier practice. But, the demonstrations conducted on the private farmers' fields by scientists, preferably from research institutions and universities, are known to have the greatest impact. Naturally, the scientist would be better equipped to answer questions, to allay fears where necessary, to identify field problems, and to give (because of his direct contact with the laboratories) quicker answers to the various problems, than would be possible by the Extension Officers. Joint demonstrations by scientists and extension officers would, thus, offer a practical example of the getting together of research, extension and production as envisaged in the farmers' education programme.

With a view to optimising the benefits of the demonstration on the farms organised by scientists and extension officers, it can be beneficial to have training camps of the neighbouring farmers arranged for a day or two. Whereas a mere demonstration would restrict its impact only to the beneficiary farmer and a few others in the neighbourhood, the organisation of Training Camp at the site of demonstration would provide communication to a much larger number of farmers of the area.

An important thing about the farmers' education is that it should be a continuing process like any other form of adult education. In other words, it must be self-sustaining and should not be of a terminal nature, because every year—sometimes every month, new techniques and new varieties etc. offer new opportunities and necessity for learning. If the learning process is not terminal in nature, but is a continuing one, then even the use of the common expression 'follow-up programme' would be meaningless, because, in that case, the aim would not so much be follow-up as a continuance of the opportunity for self-learning by the farmers.

The type of institution through which the education can be arranged is an important matter. The Panchayats cannot be utilised for this purpose, because they are multipurpose administrative organisations based upon political consensus rather than on common professional interests. There can be small self-study groups of farmers, or those who participate in specific production

programme, which may look a sort of midway house between a club and a guild. For example, farmers who participate in the training camps of crop demonstrations, would need to be organised into small compact groups of ten to twenty members each, in order to enable them to continue the process of learning, in between the two training camps. It will give them material and facilities for learning and for mutual discussions and observations. Radio-sets, brochures, posters, etc. and such new audio-visual devices as phone-viewers, can, if available, enable these small groups to continue their pursuit for the latest information and exchange of experiences. The group discussion can also provide a media for two-way communication between the researcher and the administrator on the one hand and the farmer on the other — a media that can be even more useful and effective than the village-level worker. This absence of the two-way communication has been at the root of the failure of many extension programmes in the past. Small groups of this kind can also be beneficial for each member of the group ultimately. For instance, a group of beneficiaries from a common tubewell can take loans collectively and arrange for the maintenance of the tubewell. They can also take on hire the harvestors for common service and acquire a common ownership of essential improved implements. From this kind of service group, the transition to an 'Interest Group' for voicing their genuine grievances and for contacting authorities can also be an easy step forward.

The new approach to Farmers' Education implies also a new concept of what is an "educator". For educating the farmers properly and adequately, services will be needed of a variety of personnel *viz.* research scientists, production staff, supplier of inputs (both manufactures and distributors), specialists from other fields such as minor irrigation, agricultural machinery, soil conservation etc., bank officers engaged on loan programmes among farmers, staff specifically employed for farmers' training in selected districts and the normal extension staff. However, the staff employed specifically for farmers' training will have to play a crucial co-ordinating role. They will have to look upon themselves not as exclusive communicators, but primarily as a cadre offering its services to the other categories of personnel mentioned above. They

should be on the look out for the various kinds of programmes of production or provision of infrastructure and inputs and to contact the people responsible for such programmes with the offer to arrange instruction, communication and media-facilities etc.

The farmers' education programme needs an institutional base and a campus. The campus can be either at the University department or at the Gram Sevak Training Centre or some other suitable place. This campus can serve not only as the baseline for the other aspect of the training, but it can also organise short duration specialised courses. One of the features of the new technology, even of HVP and multiple cropping, is that certain items of work which the farmer was not bothering about in the past, have now become of much interest to him. Examples can be cited of the drainage, soil conservation, new techniques of fertiliser application, tubewell operation, minor repairs to machinery, tractor driving, use of power sprayers etc. etc. Not all the farmers may be interested in them but some may — and a few may even wish to make it a side-profession by providing specialised services of this kind to other farmers. For these farmers, special short courses may have to be organised at the campus with duration varying according to the nature of training and needs of the farmers.

The training programme for women also requires reorientation. Due importance has not been given to farm women in farmers' training programme. Most of the training programmes for women were in various aspects of Home Sciences, and inevitably tended to be rather urban oriented. They will, no doubt, continue to be useful, particularly in view of the varieties of cereals and of the ancillary foods. But, it is the training of women in the appropriate functions of actual farm operations like cattle-rearing, milk-production, poultry-breeding etc., which has yet to receive proper attention. The new concept and programme of farmers' training will have to involve women in the training programme after identifying the tasks which they usually perform in the different parts of the country. In some areas, women labourers are distinct from the owner farmers, and since the training is generally confined to the owner farmers, the labourers are left out. Special efforts are, therefore, required to involve the women labourers in the farmers' training programmes. Farmers'

wives should also be given training even if they are not performing the tasks, because they play an important role in decision making and in farm planning.

**2. Farm Broadcasts**

The All-India-Radio provides information support to the farmers' training and education programme. In each training district, there is a Radio Contact Officer who is responsible for collecting information about the High Yielding Varieties Programme from all the relevant sources and feeds it back to the farmers through the radio. The programme of national demonstrations and other agricultural activities in the district are supported by bi-weekly radio broadcasts, on fixed days during a week, by the Farm and Home Unit of the All India Radio. In addition, special information of urgent nature, such as outbreak of pests and disease in epidemic form are also broadcast as and when necessary.

Twenty-seven special Farm and Home Units of the All India Radio have, so far, been established at various AIR stations to give radio support to the farmers training programme. It is proposed to start 10 additional Farm and Home Units in 1970-71, and other 9 in 1971-72, bringing the total to 46, so as to cover adequately all the districts proposed to be brought under the Famers' Training and Education Programme.

The audio-visual media, if utilised properly, by providing different kinds of diversion, can offer vast potentialities for the farmers' education programmes. There should be a specific use of audio-visual media rather than the present diffused one. The usual radio and film programmes meant for rural audience should reach the rural community as a collective organism and all its multifarious needs pertaining to health, production, cultural activities, crops, weather, family planning, traditional customs etc. should be referred to in a 'basket' like manner. The media programmes should be fewer, but should be instructional and problem-oriented. Instead of attempting to achieve a popular appeal through having programmes of a general nature, certain appropriate pedagogic techniques can be used in the programmes to facilitate assimilation of the instruction and guidance by the farmers.

The mass media programmes should be local rather than national. One of the common shortcomings of the centrally produced posters, brochures, films etc. is that they overlook the local conditions, crops and their problems. A mass media programme, therefore, should invariably be adapted to the local needs. Besides, the different media like film, radio, posters and the printed word, should be interrelated and their timings synchronised with the various stages of the specific operations of the farmers. The optimum effect of the audio-visual media can be obtained only if the various media reinforce each other rather than diffuse the total effect.

### 3. Functional Literacy

In the Centrally sponsored programme of farmers' education and training, functional literacy is sought to be organised among illiterate groups of farmers with a view to making them functionally more efficient in the context of modernising agriculture.

Functional Literacy progrmme has, so far, been taken up in 25 selected HVP districts. It is proposed to extend the programme to 35 more districts in 1970-71, and to another 40 districts in 1971-72 so as to cover in all 100 districts. At the rate of 60 Functional Literacy Centres in each district, the programme is expected to be extended to 6000 Literacy Centres by the end of 1971-72.

Literacy happens to be an important pre-requisite for giving equal opportunity to the farmers adopting new technology. But farmers' education programme in the past did not involve any specific action for providing literacy to the illiterate farmers because of the general belief that a farmer can learn by seeing and hearing and that illiteracy is not a handicap for him. This may be generally true, but, as technology becomes complex, not only understanding, but also retention of the new technology becomes crucial. Farmers are known to have excellent memory. But there are limits to it. The resourceful educated farmer will always have an advantage over the illiterate small farmer. Experience has shown that the ignorance of certain laws is one of the big handicaps for the small farmer and the agricultural labour. Besides the tenancy laws, there are laws like the Minimum Wages Act that are rarely known. It is true that quite a

few terms of the revenue laws are generally understood in villages, but if most of the farmers have early access to the text and interpretations of the text, things would, no doubt, be much better for them. In the light of these circumstances, the new programme of farmers' training and education should include what is known as 'Functional Literacy'. The literacy primer especially designed for the effort should contain basic information in regional languages, on agricultural inputs, required in the High Yielding Varieties Programme, preparation of farm plans, maintenance of farm-accounts, posting of input cards etc. In short, the literacy effort should be tuned to the requirements of the farmers and should serve as a tool for bringing about improvement in farming practices.

"Functional Literacy" is different from ordinary literacy in two ways: Firstly, instead of using the usual primers, it seeks to acquaint the learner with the words that he has actually to use in his farming operations — in the accounts books, in the credit applications, in the use of inputs and in regard to the legal matters concerning revenue laws etc. In fact, some of those very documents can be used as the primers, or at least, a selective vocabulary can be culled out of them. Secondly, unlike a normal literacy programme, the learner in this case has to start using the skills of reading and writing while he is still learning them from day to day. He does not have to wait until the end of six months, to be able to read the names of the fertilizers or seeds etc.

In addition to the above mentioned Central programmes for the education and training of the farmers in HVP areas, there are also certain programmes undertaken by the State Governments and certain others taken up at the instance of the various Divisions of the Union Government and other agencies. But these programmes are not necessarily following the new approach, except in so far as they are related to the specific activities and development programmes. Examples of these programmes are the various training programmes in agricultural implements and machinery, poultry, introduction of new cattle breeds, soil conservation, new technique of logging timber, new practices of water management etc. etc.

Some non-governmental agencies are also involved in different kinds of training programmes with or without government assistance. For example, under the "Freedom from Hunger Campaign", 12 Farmers' Training Projects have been initiated at the instance of India's Freedom from Hunger Campaign Society. These are broadly following the new concept of Farmers training. A number of fertilisers manufacturing firms have also been conducting excellent programmes of demonstrations on the fields. Though, training camps of farmers have seldom been organised by them, their impact has been perceptible, and, in some cases, fairly widespread. Demonstrations in some of the foreign-aided projects such as the Mandi Project, have also served the purpose of Farmers' Training to some extent.

*Farmers' Training and Education needs a kind of coordinated* effort on the part of diverse agencies and authorities that has never been attempted before at the field level because the use of modern technology, as in HYV, involves diverse functions and processes and since the definition of the "Education" has been enlarged substantially. The agencies associated with this education programme are :

(*i*) Universities, research centres and other training and educational institutions.

(*ii*) Production wings of the Agriculture Departments as well as officers concerned with laying out of programmes such as High-yielding varieties programmes in the districts and blocks.

(*iii*) Extension and training directorates and officers at the State-level as well as at district and block levels.

(*iv*) Information units of the State Governments Agriculture Departments and of the Extension Directorate.

(*v*) Information media of the Ministry of Information and Broadcasting of the Government of India *e.g.*, All India Radio, Films Division, Field Publicity organisation etc.

(*vi*) Local panchayati institutions.

(*vii*) Credit and financing sections and officers of the State Government cooperative organisations and commercial banks.

(*viii*) Units of Government as well as public and private sectors that are responsible for the Supply of inputs such as fertilizers, seeds, pesticides, etc.

A coordinated approach in farmers' training programme, howsoever desirable it may be, is not easy to realise. There have to be coordination committees which should be answerable for different elements of the programme. Secondly, at every level, there should be a coordinator. He may not necessarily be the decision maker. There is a distinction between a coordinator and a decision maker : decision may have to be taken by people responsible for various specialised aspects of a programme, but, since these aspects impinge upon each other, there has to be somebody who has to be vigilant about these points of contacts and to arrange co-relation. Thirdly, in any attempt at coordination, it becomes important that each agency should accept the responsibility to inform others concerned of the steps taken by it. For example, in the selection of the demonstration farms by the research scientists, there should be a prior consultation with the production wing and the training staff. Preparation of chart and reading material by information units should be done in consultation with the researchers and local production staff. The dates of training camps should be fixed by extension officers in consultation with research staff and media agencies. Radio programmes should be worked out by the radio authorities in consultation with the production wing, the researchers and the training staff. It is obvious that unless there is coordination in these details, even a well intentioned training and education programme will remain infructuous.

## VI. Power

Power is an important item in the infrastructure for agricultural development because tubewells operate with power. There has been a substantial growth in the installed capacity for power generation which rose from 2·3 million Kw at the end of 1950-51 to 17·8 million Kw at the end of 1970-71.

### RURAL ELECTRIFICATION

The programmes of rural electrification were not given much

importance in the first three plans. Rural electrification then meant only an extension of electricity to villages. In the year 1966, in the wake of the drought and the sharp decline in agricultural production, the National Development Council reviewed the role of rural electrification and directed that the rural electrification programmes should be oriented towards providing electric power to pumpsets with a view to assisting the overall programmes for augmenting agricultural production. This shift in emphasis was followed by an accelerated pace of the rural electrification programme in the country. Whereas, upto 1965-66, the total number of villages electrified and the total number of irrigation pumpsets energised by electric power were 44,494 and 5,13,026 respectively, by 1970-71, the respective numbers rose to be 100,000 and 1,500,000. This means that the performance in the last five years was even better than the aggregate performance in the preceding fifteen years. The Fourth Plan aims at energising an additional number of 1·25 million pumpsets by 1973-74. Though no specified target has been laid down in terms of the number of villages covered, the perspective planning for rural electrification aims at covering 50% villages of the country by 1980, as compared to 18% at the end of March 1971.

The greatly accelerated pace of the rural electrification programme brought into a sharp focus the need for a financing institution which could look at the rural electrification programme from a commercial point of view and, at the same time, combine the commercial approach with the needs of the development. All investments in rural electrification so for, had been done out of plan resources through State Electricity Boards. The Electricity Boards, while spending the amounts on specific programmes, were motivated more by a sense of social duty to extend electrification to rural areas and less by the desire of earning a remunerative return on the capital invested. It was, therefore, felt that an all-India institution devoted exclusively to the financing of rural electrification projects could pay proper attention to the economics of electrification projects and also help the Electricity Boards in making judicious investment of their funds in schemes which would satisfy the twin criteria of economic returns and developmental urgency.

**The Rural Electrification Corporation**

The Rural Electrification Corporation came into existence on the basis of a recommendation made by the All India Rural Credit Review Committee in 1969. This Committee, in the course of its comprehensive review of all sources of rural credit in the context of the growing needs of agriculture, *inter alia*, concluded that for the modernisation of agriculture in India, a massive programme of rural electrification was essential because farm mechanisation and adoption of improved practices would depend very largely on the availability of assured irrigation through the use of electricity. The report of the All India Rural Credit Review Committee says :—

> "The importance of rural electrification, not only generally, but in the specific context of the plans for increased agricultural production. can hardly be over-emphasised. Minor irrigation, as we have seen, is emerging as one of the principal objectives of long-term institutional credit for agriculture. This is especially so with reference to schemes for the sinking and energisation of wells. While loans are advanced for wells and electric pumpsets, the failure to provide power holds up the energisation of the wells and the adoption of improved agricultural practices or remunerative cropping patterns... It is clear that planned rural electrification is a very necessary adjunct to planned irrigation. It is also clear that programmes of rural electrification should be complementary to schemes for the construction of wells and installation of pumps. . . Indeed, the fruitful utilisation and prompt repayment of institutional credit provided for these purposes depend upon the simultaneous extension of the supply of electricity to the relevant areas".

The Rural Electrification Corporation came into existence in July, 1969, with the following main objectives :

(*i*) To finance rural electrification schemes in the country ;

(*ii*) To subscribe to special rural electrification bonds that may be issued by the State Electricity Boards on conditions to be stipulated from time to time :

(*iii*) To promote and finance rural electricity cooperatives in the country ; and

(*iv*) To administer the moneys received from time to time from the Government of India and other sources as

grants, or otherwise for the purposes of financing rural electrification in the country in general.

In carrying out the above objectives, the R.E.C. is guided by certain directives given by the Government of India. The important points in these directives are :

(*i*) The R.E.C. should consider schemes for financing on the basis of a project approach ;

(*ii*) The R.E.C. should provide financial assistance for schemes which satisfy some criteria of economic viability, and in particular, help increase agricultural production ;

(*iii*) In financing projects, the R.E.C. should give special consideration to the requirements of relatively backward areas and may offer preferential terms and conditions of loan for such areas ; and

*iv*) The R.E.C. should help to promote some pilot rural electric cooperative projects and generally should try to promote the cooperative method of distribution of electricity in the rural areas.

The principal borrowers of the R.E.C. are the State Electricity Boards. The State Electricity Boards in India are public sector undertakings constituted in each State (barring three States) by the respective State Governments in pursuance of the provisions of the State Electricity Boards Act. They have generally been vested with the responsibility for generation, transmission and distribution of power within their respective States. Apart from the State Electricity Boards, the R.E.C. has, at present, five borrowers in the cooperative sector, *viz*, five pilot rural electric cooperation societies set up in selected areas of five states of the Indian Union.

The viability of a scheme is an important criterian for its sanction by the R.E.C. It has been indicated to the State Electricity Boards by the R.E.C. that economic viability would mean the prospects of sufficient revenue from sale of electricity to rural users to cover — (*a*) operating cost; and (*b*) an appropriate return on investment which will enable the Electricity Boards to pay interest and repay the loan instalments from the surplus, within a reasonable period of time. In the case of economically backward areas, however,

a waiver for a short period not exceeding five years could be considered for repayment of the loan instalments. Before agreeing for the assistance, the R.E.C. satisfies itself about the technical, economic, financial and managerial soundness of each scheme. In backward areas, the R.E.C. also considers the future potential for growth. In considering the economic viability of the schemes, the R.E.C. goes by a prescribed schedule of minimun anticipated return.

The total period for the repayments of loans has been fixed at 35 years for Cooperatives, 30 years for schemes in the 'backward areas' and 20 years for schemes in 'other areas.' In all cases, the Corporation allows a period of moratorium for 5 years for repayment of principal.

The R.E.C. has devised the interest rate structure in such a way as will yield an average of 5½% per annum on the loans issued by the Corporation.

With a view to ensuring security, the Corporation has stipulated that its loans to the Electricity Board should be guaranteed fully by concerned State Governments in respect of payment of interest and repayment of principal.

In about one year of its existence, the R.E.C. approved 65 schemes sponsored by State Electricity Boards and 5 pilot rural electric cooperative projects for issue of loans totalling Rs. 462 million. These schemes will, on completion, cover 6,428 villages and give electric connection to 1,20,460 agricultural pumpsets and 18,330 rural industries.

The main considerations for the determination of the eligibility of schemes for financial assistance by R E.C. are as follows :

(*i*) The project concept;

(*ii*) Economic viability with special reference to increasing agricultural produdtion;

(*iii*) Special needs of relatively backward areas; and

(*iv*) Special needs of cooperativ o projects.

Whenever a scheme comes up for consideration, the R.E.C. looks into it not merely as an engineering project aimed at extension of electricity to certain villages and provision of connections to certain points, but also for the totality of economic activity in the area and the part which electricity will be able to play in supporting and stimulating that activity.

The rural electric cooperative projects are schemes of area coverage under which the cooperative society takes a distributing licence and is obligated, under law, to provide connection to any consumer within the area of its operation. Some of the areas covered by cooperative projects are also urban or semi-urban in character and, sometimes, they have to cater to bulk consumers also. Moreover, the cooperative societies have to take over the existing assets and installations within the project area from the State Electricity Board and they have to lay out further distribution lines. The R.E.C. has agreed to provide loans to these societies to meet the cost of taking over of existing assets from Electricity Boards as well as construction of new lines and servicing connections to be required within a period of 5 years. In view of the special nature of the cooperative projects, the R.E.C. has not laid down any criteria to determine their viability. In sanctioning the loans, however, the R.E.C. satisfies itself that at the end of the fifth year, each of the societies has a net surplus, and the profitability increases at the end of the tenth year and the fifteenth year. Special terms of loan were provided to the five pilot cooperatives. It was expected that these cooperatives, being organisations of consumers, would be able to give close attention to the needs of the rural areas within their coverage and their functioning being consumer-oriented, would be conducive to economy and will provide built-in safeguards against thefts of electricity or otherwise unauthorised uses of electricity. After the first five pilot projects have been observed to function successfully, there are plans for setting up of similar projects in other areas also.

The R.E.C. is the first all-India financing institution engaged exclusively in the task of financing rural electrification projects which are economically viable and aim at stimulating the economic development of the area. It had long been the generally held view that rural

electrification is not a profitable proposition and that the State Electricity Boards can undertake rural electrification schemes in the discharge of their general developmental responsibility criteria. This view which continues to be held in wide circles even today is not, however, borne out by certain studies which have been made recently by the National Council of Applied Economic Research. A recent study of the Impact of Rural Electrification in Punjab, says :

> "The estimated gross revenue from the consumers of electricity in rural areas in Punjab as a percentage of the capital cost of rural electrification worked out to 29. 12%. The operating and maintenance expenditure on the rural electrification schemes is estimated at about 27 per cent of the gross revenue. Thus, in the net, the rural electrification schemes in Punjab have proved to be financially viable."

The position, however, has been found to be somewhat different in Kerala. A report on the impact of Rural Electrification in Kerala says that it is difficult to conclude that rural electrification in Kerala is an economic proposition. It should be noted, however, that whereas in Punjab, electrification of agricultural pumpsets was the most significant part of the rural electrification programme, it was not so in Kerala. It may be possible to explain the better profitability of rural electrification in the Punjab villages as being attributable to the greater emphasis on energisation of irrigation pumpsets and, consequently, larger use of power for agriculture, which in turn, has given appreciable economic benefit to the farmers. While in the matter of profitability to the State Electricity Board in relation to its investment in rural electrification, the position in Kerala has been found to be not as good as the position in Punjab, studies in both Kerala and Punjab have, however, revealed that the end-users of electricity, namely, the farmers and the rural artisans have been greatly benefited : their economic operations have become more remunerative, and in terms of its impact on the rural economy as a whole, the benefits of rural electrification can hardly be disputed.

The findings of a study made by Prof. K.S. Sonachalam on the 'Electricity and Economic Development of Madras State also show appreciable benefits derived by the farmers as well as rural industries

from rural electrification. A sample survey conducted by the Planning Commission for Tamil-Nadu has also revealed that for each unit of electrified pumpset, on the average, an additional area of 3 acres has been brought under paddy cultivation, and on the basis of a half ton of yield per acre, 4,70,903 electrically operated pumpsets existing in Tamil-Nadu by the end of March, 1970, can be said to have contributed additional food production of the order of 7,00,000 tons valued approximately at Rs. 350 million. Certain specialised studies on the economics of rural electrification and lift irrigation in Gujarat state, made by Dr. S.M. Patel and Mr. K.V. Patel under the auspices of the Indian Institute of Management, Ahmedabad, also bear out the large benefits derived by farmers from rural electrification as well as the increase in the profitability of the rural electrification programme. From the above, it can be concluded that the rural electrification is, and can be made, an economically viable programme provided that the State Electricity Boards carry out pre-investment surveys prior to the selection of areas and establish necessary co-ordination with other developmental authorities in the state in the fields of agriculture and rural industries.

## VII. Transport & Communication

*Railways.* Railways offer a convenient means of transportation for the agricultural produce when distances involved are comparatively large. The extension of the railway route length has been rather insignificant from 53,955 Kms. at the end of 1950-51 to 59,560 Kms. at the end of 1968-69. This gives only a ten per cent increase during this period. Large areas of the country in Rajasthan, Madhya-Pradesh, Maharashtra, Orissa and Andhra-Pradesh are still without the necessary route mileage, and economic development of many regions in these and other states has suffered primarily because of the absence of railway routes in these reigons. During some years of the second plan period the railways became a major bottleneck for the Indian economy and a good deal of damage was done in those years. But corrective measures were taken soon, and taking the period as a whole, the capacity expanded from 93 million tonnes in 1950-51 to 203 million

tonnes in 1968-69. This broadly met the requirements of the economy.

At the beginning of the Fourth Plan period, work was in progress on construction of a number of new railway lines over a length of 1,022 kilometers. Besides this, there is a limited provision of new lines in the Fourth Plan period.

Railways are particularly useful for transporting perishables over long distances. The existing arrangements in this regard are far from satisfactory. Refrigeration vans are pratically non-existent. Even ventilated wooden wagons are not available in sufficient numbers for the transport of fruits and vagetables, which have, therefore, to be carried in the steel wagons. As these steel wagons rarely have any ventilation, considerable spoilage is caused during transit.

*Roads.* About 80 per cent of the villages in India are not connected with any market by pucca all-weather roads. Absence of roads is responsible to a large extent for the reluctance of the farmer to bring his produce to the markets. Construction of feeder roads from village to the market centres is, therefore, urgently needed.

There is, however, a peculiar division of labour in India in ragard to roads. While road construction lies in the public sector, the business of running the vehicles, particularly the goods vehicles, is in the private sector. The road network has been expanded from 157,000 Kms. in 1950-51 to 325,000 Kms. at the end of 1968-69. In absolute terms, this doubling of the road length may look impressive, but, on the whole, the road system in India has still large deficiencies. The National highway system has about 400 kilometers of missing road links and 17 missing major bridges. Of the total length of 24,000 kilometers of national highways, about 2/3rds have single lane width. The state road systems also suffer from various handicaps. Besides inadequate road length, the existing roads in many areas have sub-standard surfaces, narrow width and weak bridges. A number of roads originally meant for light traffic require to be strengthened for much higher intensities of traffic than have developed or are expected

to develop. Many backward regions and hilly areas have poor communications. A large number of villages still lack road links.

In the Fourth Plan, a provision of Rs 89 crores is proposed for augmenting the services of nationalised transport undertakings in the states. In addition, a provision of Rs 10 crores has been included in the Railways' plan for contribution to the capital of state road-transport undertakings. In the Central Plan, a provison of Rs 3 crores is proposed for the Central Road Transport Corporation which operates in the north-east region and for financial assistance to the Central Road Transport Training and Research Institute, Poona. A large part of the expansion of road transport is expected in the private seetor which is expected to make an investment of Rs 935 crores during the Fourth Plan period.

The fleet of commercial vehicles which has expanded from 116 thousand vehicles in 1950-51 to 370 thousand vehicles in 1970-71, will be raised to about 470 thousands by the end of the Fourth Plan period.

*Radio and Television*—One of the reasons why the farmer is not able to take advantage of a favourable market is the absence of information about price trends. An effective system of relaying market news can be evolved through the radio and television.

Radio came to India in 1920s. At the time of independence, India had hardly a dozen radio stations. The number has now risen to 63. The number of radio sets increased from 4 lakhs in 1947 to 80 lakhs in 1968-69 and to 100 lakhs in December 1970. About 25 lakh sets are in the rural areas. Besides, the rural areas are supposed to be having another 25 lakh sets out of the estimated 50 lakhs of unlicensed sets

During the Fourth Plan period, a provision of Rs 40 crores has been made for expansion of broadcasting facilities. At the end of the Fourth Plan, nearly 80% of the population in all the states and Union Territories would be covered by medium-wave broadcasts.

Television has also come to India and, by the end of the Fourth Plan, the existing facilities will be strengthed at Delhi and new tele-

vision centres will be opened at Calcutta, Madras, Kanpur, Lucknow, Srinagar and Bombay (with relay facilities at Poona). The usefulness of Television as a media for the education and training of the farmers can hardly be overemphasised.

## VIII—Administration

Administration is an essential part of the infrastructure and in the absence of an efficient administrative machinery no important programme can be launched and implemented. Before 1965, the Central organisatton did not possess a coherent and well integrated structure. In addition to the Secretary (Agriculture) there was a Secretary level officer in charge of Extension, a Secretary level officer in charge of the Indian Council of Agricultural Research and a Secretary level officer in charge of Cooperation. Community Development was independent under an Additional Secretary. During 1965, a complete reorganisation of the above mentioned set up was undertaken by Shri C. Subrahamaniam, then Minister for Food, Agriculture, Community Development and Cooperation. The biggest change that took place in the said reorganisation was the concentration of control over Agriculture, Cooperation and Community Development under one Secretary and placing the Research separately under the Director General of the I.C.A.R This concentration of control under one head greatly facilitated the growth of ideas and administration in agriculture.

During 1970-71, the central organisation was a better organised system as a result of the reorganisation. The department now has ten wings and four specialised offices. The ten wings deal with :

1. Production (Crops and Animal Husbandry) ;
2. Land and water ;
3. Soil and Water:
4. Inputs;
5. Credit and Marketing;
6. Machinery;
7. Fisheries;
8. Forests ;
9. Land Reforms; and
10. Agricultural Census and Administration Coordination.

The four specialised offices are :

1. Indian Council of Agricultural Research;
2. Directorate of Economics and Statistics;
3. Directorate of Extension; and
4. Agricultural Prices Commission.

There are also several operational and supervisory agencies which are treated as the subordinate attached offices. These include Directorate of Marketing and Inspection; Directorate of Plant Protection, Quarantine and Storage and a number of Commodity Development Offices and Institutes under the Animal Husbandry, Fisheries and Forestry Divisions. The I.C.A.R., which has an autonomous status, has 33 institutions and centres for research and training purposes in different parts of the country, and is also the coordinating body for Agricultural Universities.

During 1970-71, I.A.D.P. and the Mobile Soil Testing Programme were brought under the direct control of Agricultural Commissioner in the Production Division. The Aerial Unit of the Directorate of Plant Protection was separated, and, in its place, the Directorate of Agricultural Aviation was set up as a subordinate office under the Department of Agriculture with the Director of Agricultural Aviation as its head.

A significant development during 1970-71 was the setting up of the National Commission on Agriculture, to enquire into the progress, problems and potentials of Indian Agriculture The Commission was inaugurated by the Presided of India on 16-10-1970 and was headed by Shri C. Subrahamaniam upto 28-1-1971.

# 5

# Water

Water in adequate quantities, and at the right time, is one of the basic determinants of agricultural productivity. Given assured water supply and good seeds, high crop yields can be achieved by the use of fertilisers, manures and improved methods of cultivation. One of the major impediments for full exploitation of the possibilities of intensive agriculture is lack of assured and dependable water supply throughout the year. Only 22 per cent of the cropped area in India has assured irrigational facilities — the remaining 78 per cent or so being dependent upon the vagaries of monsoons.

## POTENTIALS

The mean annual rainfall of India is about 42". It is unequally distributed over the country, being as little as 3·3" in Rajasthan in the north-west and as high as an average of 460" at Cherapunji in the north-east. In each region, the rainfall varies greatly from month to month and the bulk of it (about 75%) occurs during the monsoon months from June to September. On the South-east coast and the eastern half of the southern part of the peninsula, there is considerable rain during October to December.

Rivers in India constitute a potential source of irrigation. The northern rivers comprising the Indus, Ganga and Brahmputra systems are perennial rivers. After the monsoons, they drive supplies from snow-melts in the Himalayas. The flows in the streams of peninsular India fall rapidly after monsoons and are reduced to a trickle during the rainless months of May and June. The range

between the minimum and maximum flows for the northern rivers is between about 2,000 and 8,00,000 cusecs (cubic feet per second) for the tributary streams and from about 30,000 to between 2 million and 3 million cusecs for the Ganga and Brahmputra. In the case of peninsular rivers like the Mahanadi, the range is between a few hundred cusecs in the dry months, to about 2 million cusecs in the monsoons.

**In almost all the states, there is the problem** of too much water during the monsoons and too little of it during the subsequent dry months — the problem of Floods and Droughts, as it is commonly known. In one or more parts of the country, devastating floods occur, destroying crops, life aad property over large areas. In other parts, and occasionally in the same part, droughts occur destroying the standing crops and bringing about famine or near famine conditions.

The approximate area liable to flooding in the country, that can be reasonably protected, is estimated around 16 million hectares. The average annual area affected by floods during 1953 to 1968 was six million hectares, of which the area under crops was 2 million hectares. Loss on account of damage to crops, property and cattle wealth runs into tens of crores of rupees every year.

**The droughts in Bihar and Orissa,** during the years 1965 to 1968, offer a typical example of the havoc caused by droughts. In Orissa, crops were wholly or partly destroyed over the bulk of the uplands in the northern and western districts. There was scarcity of drinking water and the cattle died by the thousands. The loss to the farmers is estimated at Rs. 100 crores in crops and Rs. 10 crores in distress sales. The widespread human misery was in addition to that loss. These droughts are not a new phenomenon in India. Exactly 100 years back, in 1865, the rainfall was scanty and had ceased prematurely. As a result, the food crops failed, and it was estimated that nearly one million people had died in the district of Cuttak alone. In the district of Puri, nearly 40% of the population had perished. And, whatever was left of the crops and property, was destroyed by the all devastating floods that followed in 1866.

This eternal problem of floods and droughts in India is in fact a challenge as well as an opportunity. If the waters which run waste to the sea, doing large-scale damage and destruction en-route, can be harnessed and released in regulated supplies, there can be immense opportunities for providing irrigational facilities and generation of hydro as well as thermal power. In addition, large quantities of water will become available for the hundreds of industries like steel, fertilizer, refineries etc, and for domestic use for millions of people.

India's water resources in the form of rivers and the groundwater storages are fairly evenly distributed over the entire country. Except for Rajasthan and Ladakh, some parts of Maharashtra and also some pockets here and there, there is enough water in the form of rainfall and groundwater storage, which, if conserved and utilised judiciously, can ensure adequate and assured water supply to most culturable areas and also for industrial and other uses in each region and state.

The average annual surface water resources of the country have been placed at a total of about 168 million hectare meters. Out of this, only about 56 million hectare meters can be used for irrigation due to various physiographical limitations. Upto 1951, only 9·5 million hectare meters were utilised. By the end of the Third Plan, the volume of utilisation rose to 18.5 million hectare meters, or nearly one third of the total availability. During 1966-69, the utilisation is estimated to have recorded a further increase of about 2 million hectare meters. During the Fourth Plan period, it is proposed to bring about an additional utilisation of 5 million hectare meters under major, medium and minor schemes, bringing the total utilisation to 25.5 million hectare meters, or 46 per cent of the usable flow.

About 22 million hectare meters of ground water can be exploited for irrigation purposes to serve 22 million hectares. At the beginning of the First Plan, 6·5 million hectares had been developed. This rose to 8·2 million hectares at the beginning of the Third Plan and to an estimated 10 9 million hectares by 1968-69, leaving a balance of about 11 million hectares to be covered subsequently.

The maximum area that can be irrigated from major, medium and minor schemes (excluding ground-water) by using 56 milion hectare meters of water has been assessed at 60 million hectares, of which about 45 million hectares would be under major and medium irrigation and 15 million hectares under minor irrigation. At the beginning of the First Plan, 9·7 million hectares were irrigated from major and medium works and 6·4 million hactares from minor irrigation. The potential created at the beginning of the Third Plan was 14·4 million hectares from major and medium schemes and 6·6 million hectares from minor schemes. The potential expected by 1968-69 was 18 5 million hectares from major and medium schemes and 8·1 million hectares from minor schemes, making a total irrigation potential of 26·6 million hectares from surface water resources. Adding the 10·9 million hectares from groundwater resources, the aggregate irrigation potential for 1968-69 worked out to 37·5 million hectares.

As against the existing irrigation potential of less than 40 million hectares in the beginning of the Fourth Plan period, about 82 million hectares can ultimately be irrigated. According to the Fourth Plan, it is important to create the balance of the irrigation potential in a period of about 15 years for groundwater resources, and within 20 years for surface water resources.

## PLANNING

Agriculture is not the only claimant for water. Industries, as they develop, will need huge quantities of water. With the growth of industrialisation, the society in India will become more and more consumption-oriented as has been the case in all industrialised countries. The rapid increase in population will result in multiplying the domestic water requirements manifold, and constitute another major demand for water. All plans for conservation and utilisation of water have, therefore, to take note of all these various factors.

In the not too distant future, our requirements of water may exceed its availability, at least in certain regions, and make it imperative for us to turn to sources other than surface and ground waters. The most important such source will be the sea. For purposes of irrigation, as well as industrial and domestic uses, we

may have to resort to desalinisation of sea water to feed the coastal areas and, may be, even some other areas within economic reach. Countries like Israel and the State of California in U.S.A. have already taken to extracting water from the sea.

Most of the major and many of the medium irrigation projects in India can be developed into multipurpose projects. It is, therefore, possible to plan developments for maximum overall benefit and, thereby, to secure maximum overall economy as well as economy for each component unit.

There are three distinct stages in the development of water resources. Firstly, there has to be an assessment of the water resources, both surface and ground-water, in a particular river basin and in each of its tributary basins. Secondly, there has to be a comprehensive survey of the terrains, their topography, soil classification, temperature, rainfall characteristics, types of crops and their water needs. Thirdly, there has to be an appraisal of the facilities other than irrigation, which can be profitably included in the water project. The best course then would be to concentrate efforts and resources on carefully selected projects and to complete them as quickly as possible. This will cut down the period of gestation, bring about early results and improve the physical and financial returns of the project. Spreading efforts and resources too thin and too wide results in unusual delays, which make the project unremunerative on the whole, due to the inclusion in its cost structure of the expenditures which could otherwise be avoided.

The planning for water resource development, for optimum results, should be according to river basins, wherein plans of each tributary sub-basin should constitute an integral part of a Master Plan for the basin. Such planning should pay due regard to the interest of each state or area within the basin, consistent with the overall national interest.

The water planning for agriculture should provide for an integrated utilisation of surface as well as ground waters and provision should be made for adequate drainage facilities in all irrigation projects. Excessive use of surface waters for irrigation may lead to un-

due rise in the level of ground-water, resulting in water-logging, salinity or alkalinity in the top soils and also serious drainage problems. Excessive pumping from ground-waters, without recharge from rainfall or irrigation operations, may result in progressive lowering of the ground-water level to uneconomic depths or even exhaustion of the ground-water storage. In the alluvial plains of northern India and the coastal plains of the peninsula, a combination of withdrawal from surface-water sources (stream flows or storages) and ground-water will help maintain the water equilibrium of the soil, prevent water logging and avoid drainage problems. It will also release precious waters for extension of irrigation facilities to other areas.

In the case of uplands of the peninsula and the eastern states, where the stream-flows dwindle to trickle after the monsoons, any works for diversion of stream-flows will become inoperative a few weeks or so after the rains, and ground waters in the sub-soil rocks, if available, will be the only hope for protecting late *Kharif* or subsequent *Rabi* crops.

Over a considerable part of the uplands, the sub-stratum generally consists of hard rocks where ground water storage is problematic or scanty. The only advisable course in such areas is to construct small, medium or major storage dams to conserve the surplus flood waters and to use them in regulated releases during the subsequent periods of shortages.

There has been some controversy over the relative importance of and need for major, medium and minor irrigation works. In reality, there is no conflict between the three categories. Each one is important in its own special field.

Minor irrigation works, wherever feasible, are important for local areas because of the relatively small capital investment and quick results. They are mostly in the form of small tanks or reservoirs, diversion bunds across small streams, dug-wells and tube-wells. If carried out with due care and expedition, they can be taken up by the thousands and their cumulated results in irrigation and food production can be very substantial and quick. The main drawback is that diversion works and small tanks fail in their

purpose, particularly in the upland areas, if the rains fail. The dugwells in the upland areas suffer from the same drawback. This is the major problem of the upland areas where droughts are a common feature. The deep tube-wells, however, function irrespective of the rainfalls.

By far the most important source of water supply is conservation of the surplus flood waters. Storage projects are very costly, but the results are lasting, correspondingly more significant and more reliable. All such projects come under the categories of medium and major irrigation projects. Thus minor, medium and major irrigation projects are complementary to each other and not mutually competitive, as is the common belief. If the concentration is merely on the major and medium irrigation projects, local area may well remain out of command, and these local areas, taken together over the whole of India, constitute a significant proportion of the total culturable area. If the concentration is mostly on the minor irrigation projects, then the unused water wealth of the country, which presently constitutes at least 70% of the total utilisable waters of the country, will remain mostly untapped and continue to run waste to the sea.

Also, major and medium projects are the only ones which can provide a positive and reliable remedy against floods and droughts. This underscores the need for an integrated rather than a compartmental approach to the problem of irrigation and water conservation.

The ultimate aims of the development of water resources for irrigation are :—

(*i*) to extend irrigation to the maximum acreage possible ;
(*ii*) to ensure the maximum yields per acre ; and
(*iii*) to prevent the harmful effects of irrigation.

In order to achieve the above mentioned objectives, the planning has to start at the farm level, and therefore, the irrigation development costs at the farm level should be considered in project development, if farm production goals are to be achieved. These costs should be determined and included as part of project planning.

The lack of development and support at the farm level, has caused serious delays in achieving anticipated increases in crop production. For instance, the failure to provide field channels along with the main irrigation facilities precludes any irrigation water going to such fields. The yields thus remain low and the project fails in its primary purpose. On the other hand, other projects with strongly supported farm development programmes are able to increase production materially.

The practice of organised irrigation in India has been traced to well before the Christian era. The earliest attempts comprised construction of inundation canals. A large number of tanks and dugwells was added in the later periods. The Cauvery Delta in the South was originally constructed in the Second Century A.D. and the Yamuna Canals in the North were constructed one in the 14th Century and the other in the 18th Century A.D. Extensive development of irrigation took place in the 19th Century when several old canals were re-modelled and new canal systems were constructed. As a result, the irrigated area increased from about 1 million hectares in 1800 to about 12 million hectares in 1900. The recommendations of the Irrigation Commission set up in 1901, provided a further fillip and in 1950-51 the area under irrigation increased to 22·6 million hectares (gross). The pace of development became faster after 1950-51 and all types of feasible schemes including multipurpose river valley projects storage/diversion and lift irrigation schemes and ground water development schemes were taken up. A total investment, of Rs. 2,600 crores was made on irrigation projects during the 18-year period from 1950-51 to 1968-69. This comprised about Rs. 1,750 crores on major-medium irrigation works and about Rs. 850 crores on minor irrigation works. This excludes a sizable investment made from private and institutional sources. The gross irrigated area increased from 22·6 million hectares in 1950-51 to 35·9 million hectares in 1968-69.

There have been two recent developments of significance in the field of irrigation. The first relates to the recognition of the fact that irrigation is not merely one of the inputs, but a pre-requisite infrastructure, on which depends the use of other inputs and better cultivation methods. The second relates to the almost

explosive expansion in the utilisation of groundwater through individually-owned works like dugwells, shallow tubewells and pumpsets, which provide the farmer with just the type of instant and controlled irrigation which the new high-yielding varieties require. This could be possible on account of a commensurate expansion in the rural electrification programme and the mobilisation of institutional resources for providing loans to farmers desirous of constructing their own wells and tubewells. As a result, there was a net addition of 175 thousand private tubewells during the period 1966-1969 to the number of 115 thousand tubewells existing at the end of the Third Five year Plan period. The number of electric irrigation pumpsets increased from about 0.5 million in March, 1966 to about 1·5 million by March, 1971.

Considering the huge order of capital investment in irrigation and drainage infrastructures, the need for improving the efficiency of irrigation management and the economy in the use of water cannot be over emphasised. There has been considerable awareness of this need in the recent years. Much greater efforts, however, are presently needed in three directions :—

(a) evolving improved technology specially suited to small holdings;

(b) setting up of effective governmental organisation, equipped with trained personnel, to provide technical guidance and services to the farmers in the management and utilisation of water at the farm level; and

(c) gradual modernisation of the institutional framework with a view to providing timely supplies, arranging credit and marketing facilities and encouraging cooperative collective activity in matters relating to farm water management.

It will need increased recognition that drainage system is an essential counterpart of the irrigation system to maintain the fertility of land and to avoid hazards of water-logging and salinisation. The programme of drainage construction needs to be organised on a systematic basis so that the main drains are completed as quickly as possible in the first stage and the branch and the subsequent drains are then taken up in the second stage. In previous sub-soil areas, underlain with fresh ground water, reliance could be placed on

increased ground water development for providing vertical sub-surface drainage. However, in areas which are under-laid with saline ground-water or which have a hard pan below the root zone, the problem of sub-surface drainage needs to be tackled through tile drains or deep surface drains, on an urgent basis.

There are many areas, particularly in the hard rock region, where irrigation development may not be porductive or economic, but it may still be necessary in order to avoid recurring distress to both human and cattle population. For the sake of socio-economic stability, these areas need to be given special attention during the seventies.

The government of India have set up a Panel on Water Resources which will advise, in the light of scientific and technological considerations, on long term planning of water resources including their assessment, exploitation and conservation. It will recommend the lines of research and investigation necessary for the integrated use of surface and ground water resources. It will also consider other important aspects, such as water-logging and salinity. As a step towards long-term planning, it will indicate the priorities to be followed in the survey and exploitation of water resources, both surface and underground.

## IRRIGATION COMMISSION

An Irrigation Commission has been set up by the government of India with the following terms of reference :—

(1) to review the development of irrigation since 1903, when the last Irrigation Commision submitted its recommendations, and report on the contribution made by irrigation to increase the productivity of land and in providing insurance against the vagaries of rainfall;

(2) to examine in detail, the irrigation facilities available in chronically drought affected and food deficit areas and suggest essential and minimum irrigation works to be undertaken in such areas;

(3) to draw up a broad outline of development of irrigation of all types for achieving self-sufficiency in cereals and for maximising production of other crops and to make broad assessment of the funds required for the purpose;

(4) to examine the adequacy of water supply in major irrigation projects;

(5) to examine the administrative and organisational set up for the planning, execution and operation of irrigation works, particularly with a view to speedy completion of projects and reduction of their gestation period.

(6) to suggest criteria for sanctioning of irrigation projects ; and

(7) to examine any other matter incidental or related to the development of irrigation in the country and to make suitable recommendations.

The findings of the Commission will be extremely useful for the future planning of irrigaton in the country.

# 6

# Fertilizers

The use of certain specified dosages of fertilizers is essential for realising the full potentials of new seeds. It is extremely important to know, however, as to what fertilizer should be used on a particular farm and also how much of it.

## REQUIREMENTS

The purpose of using fertilizers is to add to the soil those mineral nutrients in which the soil is deficient and is not capable of supplying to the plants the quantities required for their optimum growth. There are various kinds of fertilizers containing one or more of the needed mineral nutrients. Most of the soils require to be replenished with supplies of nitrogen, potassium and phosphorus which are taken away by the plants. Some of the soils may also require application of fertilizers containing calcium, magnesium and sulphur which are removed in relatively smaller quantities. Iron, manganese, copper, zinc. boron, molybdenum and chlorine are needed in very small quantities and the supply of these nutrients in most of the soils is generally found to be sufficient. Appropriate doses of suitable fertilizers may, however, be required to be used in the case of deficiency of one or more of these micro-nutrients.

After finding out the fertiliser that suits a particular soil, it has also to be ascertained as to what quantities would be needed. For this the soil has to be got tested by the soil testing laboratory. Normally any particular soil should be tested once in three years' time. After the soil test, the farmer may follow any one of the several approaches for building up the needed nutrient concentration in his soil. For a mobile nutrient like nitrogen, the quantity of nutrient to be applied to each crop should approximately equal the quantity removed by the crop and also otherwise lost from the soil through leaching etc. For relatively immobile nutrients like phosphorus and

potassium, the quantity of nutrients needed in a low testing soil is several times more than what a crop can remove in one season. But once this is accomplished, the nutrient concentration can be maintained by relatively smaller applications, to replenish the nutrient removed by subsequent crops. For best growth and development, all crop plants do not require the same concentration of various nutrients in the soil. The quantity of nutrients to be applied for a build up programme would, therefore, depend on the kind of crops to be grown. Different crops also do not remove the same quantities of nutrients. The quantity of nutrients that must be applied, therefore, depends upon the varieties of crops grown and the yields obtained. An approximate idea about the N, $P_2O_5$ and $K_2O$ removed from soil by important crops is given in the table below :

| | *Plant part* | *Yield (Qntls/ha)* | *Per hectare Nutrients removed (Kilograms)* | | |
|---|---|---|---|---|---|
| | | | N | $P_2O_5$ | $K_2O$ |
| Maize | Grain | 60 | 90 | 35 | 30 |
| | Straw | 60 | 70 | 24 | 115 |
| Wheat | Grain | 60 | 125 | 62 | 45 |
| | Straw | 75 | 50 | 16 | 100 |
| Paddy | Paddy | 60 | 63 | 25 | 15 |
| | Straw | 63 | 38 | 13 | 90 |
| Jowar | Grain | 50 | 70 | 44 | 20 |
| | Straw | 80 | 42 | 28 | 118 |
| Soybean | Grain | 30 | 188 | 44 | 75 |
| Groundnut | Nuts | 25 | 90 | 10 | 18 |
| Sugarcane | Stalks | 800 | 135 | 184 | 240 |
| Potato | Tubers | 350 | 80 | 60 | 122 |

There are several methods for the application of fertillzers. The suitability of each method depends upon the following four factors :—

1. The type and quantity of fertilizers to be used;
2. The type of crops grown;
3. The climatic conditions; and
4. The type of soil.

There are mobile nutrients like Nitrogen which can move with water and immobile nutrients like phosphorus, potassium, calcium, magnesium, iron, copper, zinc and manganese which cannot ordinarily move with water to any appreciable extent. The fertilizers containing mobile nutrients are either mixed with the root zone soil at the time of seed bed preparation or applied by top dressing on the soil surface in a standing crop. Fertilizers applied in this way are carried down to the root zone by irrigation or by rain water. As the fertilizers containing relatively immobile nutrients cannot be carried to the root zone by water, they must be applied in the soil at such a depth where maximum root growth takes place.

Nitrogen can be applied to soil in various forms e.g., manures, composts, oil-cakes, urea, ammonium sulphate or ammonium sulphate nitrate or as calcium ammonium nitrate. When manures, composts and oil-cakes are applied to soil, their nitrogen slowly turns into ammonium form by certain soil micro-organisms. When urea is applied to soil, its nitrogen is rapidly converted into ammomium nitrogen Nitorgen in ammonium form is absorbed by clay and organic matter in the soil and is not mobile. If oxygen is present in the soil, another set of soil micro-organism can convert the ammonium nitrogen into nitrate nitrogen. In the nitrate form, nitrogen is not held by clay and organic matter and can easily move with water. If nitrate form of nitrogen is applied or carried by water into a zone of soil where no oxygen is present, another set of soil micro-organisms can readily convert it into gas form. After conversion to gas form, the nitrogen escapes from soil into the atmosphere. In a paddy field, even under standing water, a thin layer of surface soil cantains enough oxygen for the conversion of ammonium nitrogen to nitrate nitrogen. Below this thin layer of soil (usually a few mm. thick) there is lack of oxygen and any nitrate nitrogen carried down into this zone by water is converted into gas form and lost to the soil. Nitrogen can also be lost from the soil if urea or ammonium fertilizers are applied broadcast on the soil surface and left there without rain,irrigation or interculture.

From the peculiar behaviour of nitrogen, it is obvious that fertilizer nitrogen cannot be stored in soil in substantial quantities. It has to be applied to each crop according to its requirement and the total quantity needed by a crop is to be applied in several small

doses. When a nitrogenous fertilizer is applied broadcast in standing crops, it has to be lightly mixed into the surface-soil or a light irrigation is given. Nitrate fertilizers are not to be used in paddy field or on any other crop during periods of heavy rainfall. When urea or ammonium fertilizers are applied broadcast in standing paddy crops, they are to be lightly mixed into the soil to a depth of a few centimeters.

In the case of phosphorus and potassium, if the soil test value is low and only small quantities of these fertilizers are available, these have either to be drilled along with the seed or applied in a band with a seed-cum-fertilizer drill. However, if large quantities of these fertilizers are to be used for a nutrient build-up programme, the whole or a major part of the fertilizer has to be applied broadcast and mixed into the soil by plouging or disking. If the nutrient status of the soil has already been raised to a reasonably high value and only relatively small quantities of these fertilizers are to be used for maintenance purposes, the fertilizer can be applied by any of the two methods mentioned above.

In a sandy soil, the relatively immobile nutrients also become mobile with water. It would, therefore, not be possible to build up these nutrients in the soil. These fertilizers have, therefore, to be applied more frequently. Because of their mobility under such conditions, they can also be lost through leaching.

When several crops are grown in rotation, all of these may not be equally responsive to applied fertilizers. In such cases, it is desirable to apply more fertilizers to more responsive crop and less fertilizers to less responsive crop, while the total quantity applied to the two crops remains constant. For example, when paddy is followed by wheat, gram, berseem or peas, it is better to apply all the phosphorus fertilizer to the *rabi* crop and none to rice. Similarly, when potatoes are followed by maize, soybean etc. it is better to apply all the potassium fertilizer to potato and none to the *kharif* crop.

Crop plants can also absorb mineral nutrients if these are sprayed on leaves and stems in the form of dilute solutions. This

method is used under special circumstances, particularly for the application of micro-nutrients and urea.

The chief advantage of this method of fertilizer application is that nutrients can be made available to the crop plants in the shortest possible time even under those conditions where a soil application is not feasible for one reason or the other. When fertilizers are applied by foliar sprays, usually a much larger proportion of the applied nutrients is used by the crop in question than is possible from fertilizer applied to the soil. Therefore, on a short term basis, foliar sprays may prove more economical than soil application. However, foliar sprays can only supplement the quantities of nutrients that crop plants absorb from soil, they cannot completely replace soil application of fertilizers.

## CHARACTERISTICS

*Ammonium Sulphate* — Ammonium sulphate, is a white crystalline substance, containing 20·6% nitrogen and 24% sulphur. The nitrogen in ammonium sulphate is present in the form of ammonium. When ammonium sulphate dissolves in water in the soil, the ammonium is attracted by the clay and organic matter in the soil. Nitrogen in this form, therefore, cannot move with water from one place to another in the soil. However, micro-organisms present in the soil can rapidly convert ammonium nitrogen into nitrate nitrogen. The nitrate is not attracted by soil and can move with water. Crop plants can absorb ammonium as well as nitrate nitrogen. During the process of conversion of ammonium nitrogen into nitrate nitrogen, acidity is produced. Therefore, continued use of ammonium sulphate over a period of years tends to make the soil acidic. Under water logged conditions, where oxygen is deficient, ammonium nitrogen cannot be converted into nitrate nitrogen. Therefore, when ammonium sulphate is applied to paddy soil and mixed into it, there is no danger of its being lost by leaching. Ammonium sulphate is also a good fertilizer for top dressing standing crops, but it should either be lightly mixed into the soil by interculture or an irrigation should be given after the fertilizer has been applied. Since ammonium sulphate also contains 24% sulphur, it gives better results than other nitrogenous fertilizers in those soils

which are deficient in sulphur. Ammonium sulphate should not be stored after mixing with a calcium containing material.

*Urea* — Urea contains 45% nitrogen which is present in the form of amine. It is highly soluble in water and rapidly absorbs moisture from the atmosphere. When urea is applied to soil, the nitrogen is first converted to ammonium form which, in turn, can be converted into nitrate form, if the soil is not water-logged.

If urea is applied broadcast on the surface of the soil and left there, it may absorb enough moisture from the atmosphere or the soil and get converted into ammonium carbonate. From ammonium carbonate, the nitrogen can easily be lost in the form of ammonia gas. On the other hand, if a heavy irrigation or a heavy rain follows immediately after broadcast of urea, it would dissolve in water and may percolate deep down into the soil before it is converted into ammonium. Therefore, after top dressing urea, it should either be mixed into the top soil by interculture or a light irrigation should be given. When urea is used in wetland paddy at the time of puddling, it would be better that some puddling is done before urea is applied, so that the infiltration rate of water in the soil is reduced. Urea sometimes may contain harmful quantities of biuret impurity which is toxic to plants. So, as a precaution, urea should not be drilled with the seed.

*Calcium ammonium nitrate* — Calcium ammonium nitrate contains 20% nitrogen (10% in nitrate and 10% in ammonium form) and about 10% calcium. This fertilizer comes in the form of ash coloured granules. Because of its calcium content, it is a good fertilizer for use in acid soils. Calcium ammonium nitrate is also a good fertilizer for top dressing standing crops. Since half of the nitrogen in this fertilizer is present in the form of nitrate, it may not be as good a fertilizer for transplanted paddy as ammonium sulphate.

*Ammonium sulphate nitrate* — Ammonium sulphate nitrate contains 26% nitrogen (19·5% in ammonium form and 6·5% in nitrate form) and 15% sulphur. It is an excellent fertilizer for top dressing standing crops. Since 6·5% nitrogen is present as nitrate, it may not be as good a fertilizer for transplanted paddy. The

ammonium nitrogen contained in this fertilizer produces acidity in the soil.

*Ammonium Chloride*—Ammonium chloride contains 26% nitrogen in the form of ammonium, and 66% chlorine. Because of its high chloride content it is not a desirable fertilizer for tobacco. For most other crops, it is a good source of nitrogen. The ammonium nitrogen contained in this fertilizer produces acidity in the soil.

*Sodium nitrate or Chilean nitrate* — Sodium nitrate is not manufactured in India, but is imported from other countries. It contains 16% nitrogen in nitrate form which is readily available to crop plants. Since nitrate nitrogen can easily leach from soil with water, it should not be used for paddy or any other crop during periods of heavy rains. Its continued use leads to accumulation of sodium in the soil and makes it alkaline. Sodium nitrate is hygroscopic and is difficult to handle. Because of its high cost, low nitrogen content and tendency to make soils alkaline, it is not a desirable fertilizer and is not much in use in India.

*Superphosphate* — Superphosphate contains 16% $P_2O_5$ which is water soluble. Besides, it also contains 15% calcium and 12% sulphur. It usually contains some free acid also which is responsible for the rotting of bags in which it is packed. It readily absorbs water from the atmosphere.

When superphosphate is added to the soil and mixed with it, the water soluble phosphorus is converted into a number of forms which are relatively less soluble. Some of these forms can be extracted by plant roots while some others are practically unavailable. This conversion of soluble phosphorus to less soluble forms is more complete if superphosphate is thoroughly mixed with the soil. Application of superphosphate, therefore, should be done in a band near the seed when only a small quantity of soluble phosphorus fertilizer is available to the farmer and the soil is deficient in phosphorus. In this way, the phosphorus is not thoroughly mixed with the soil and a greater proportion of it remains soluble for a larger period. The plants are, therefore, able to extract a larger proportion of the phosphorus applied as fertilizer. If some ammo-

nium nitrogen is also applied in the band mixed with superphosphate, the uptake of fertilizer phosphorus is increased further. Due to its low mobility, superphosphate should not be used for the top-dressing of standing crops.

*Triple superphosphate* — Triple superphosphate contains 40% water soluble $P_2O_5$. The advantage of triple superphosphate lies in its high $P_2O_5$ content. As the form of phosphorus present in triple superphosphate is similar to that of superphosphate, its properties and placement in the soil are same as those of superphosphate.

*Diammonium phosphate* — Diammonium phosphate contains 18% ammonium nitrogen and 46% water soluble $P_2O_5$. As it contains both ammonium nitrogen and water soluble phosphorus, it is an excellent fertilizer for band placement. Like other phosphorus fertilizers, it is not suitable for top-dressing.

*Monoammonium phosphate* — Monoammonium phosphate contains 11% ammonium nitrogen and 48% water soluble $P_2O_5$. Its behaviour in the soil is comparable to that of diammonium phosphate.

*Nitrophosphate* —Nitrophosphate contains 16% nitrate nitrogen and 13% water soluble $P_2O_5$. Its advantage over superphosphate is due to the presence of nitrate nitrogen. The other reactions in the soil are similar to those of superphosphate.

*Ammonium phosphate sulphate* — Ammonium phosphate sulphate contains 16% ammonium nitrogen, 20% water soluble $P_2O_5$ and 13% sulphur. Thus, three needed plant nutrients are supplied by this fertilizer. Its reactions in the soil are similar to those of diammonium phosphate.

*Rock Phosphate* — Rock phosphate contains 25-35% $P_2O_5$ which is insoluble in water and is very slowly available to the plants. It is useful in acid soils only. In neutral or alkaline soils, its availability is very low. It is not a suitable fertilizer for band placement or top dressing and must be thoroughly mixed into the soil whenever used.

*Muriate of potash* — Muriate of potash contains 60% $K_2O$

which is water soluble. Due to low mobility of potash in the soil, it should be placed in the root zone just like phosphorus fertilizers. Because of its high chloride content it is not a good fertilizer for tobacco.

The nutrient contents of the fertilizers mentioned above are given in the table below :— (*Percentage*)

| S. No. | Fertilizer | N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|
| 1. | Urea. | 45 | — | — |
| 2. | Sodium nitrate. | 16 | — | — |
| 3. | Ammonium sulphate. | 20 6 | — | — |
| 4. | Ammonium nitrate. | 33 | — | — |
| 5. | Calcium ammonium nitrate. | 20 | — | — |
| 6. | Ammonium chloride. | 26 | — | — |
| 7. | Ammonium sulphate nitrate. | 26 | — | — |
| 8. | Ammonium phosphate sulphate. | 16 | 20 | — |
| 9. | Monoammonium phosphate. | 11 | 48 | — |
| 10. | Diammonium phosphate. | 18 | 46 | — |
| 11. | Nitrophosphate. | 16 | 13 | — |
| 12. | Superphosphate. | — | 16 | — |
| 13. | Triple superphosphate. | — | 40 | — |
| 14 | Potassium chloride (Muriate of Potash) | — | — | 60 |

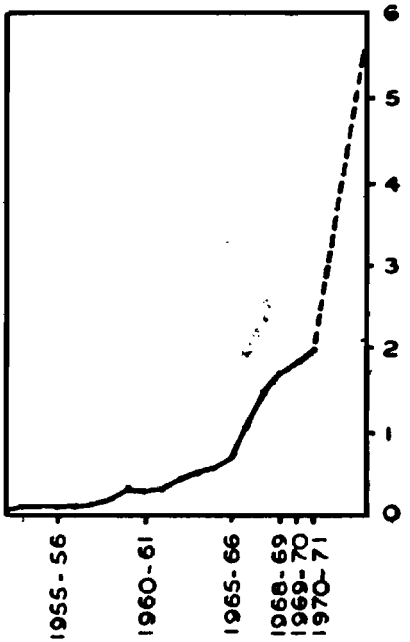
## CONSUMPTION

Of the various types of nitrogenous and phosphatic fertilisers introduced into India from the beginning of the twentieth century, ammonium sulphate and superphosphate were found to be most in use at the time of the beginning of the planning and were also being manufactured in the country. The First Plan says: "manures and fertilisers play the same part in relation to the soil as food in relation to the body..... .....organic matter, nitrogen, phosphorus and potash are the Chief constituents which must be supplied to the soil." The Second Plan proposed to raise the consumption of nitrogenous fertilizers to over 1·8 million tonnes by 1960-61 and also to step up the consumption of phosphatic fertilizers. The Third Plan laid stress on the necessity of increasing supplies of fertilisers and laid down a provisional schedule in this regard. The Fourth Plan put a great deal of emphasis on the promotion of the use of fertilisers in the country and fixed a target of 5·6 million tonnes to be achieved by 1973-74.

The consumption of fertilisers in India which increased from 121 thousand tonnes at the end of the First Plan to 265 thousand tonnes at the end of the second plan, rose to be 680 thousand tonnes at the end of the Third Plan. During the three years between the Third and the Fourth Plan, there was a considerable increase in the consumption of fertilisers and in 1968-69 it reached the level of 1·7 million tonnes.

The increase in the consumption of fertilisers during the first two years of the Fourth Plan was much smaller as compared to the increase recorded during the preceding three years and the total consumpion of fertilisers rose from 1·7 million tonnes in 1968-69 to 2·1 million tonnes in 1970-71. That the progress in raising the consumption of fertilisers in India is not commensurate with the target of 5-6 million tonnes fixed for the Fourth Plan period can be seen from the graph below :

*Consumption of Fertilisers in million tonnes*
*(Dots indicate the targets)*




In any programme for increasing consumption of fertilisers in the country, farmer will always remain an important factor. The

farmer will be guided in the use of fertilisers solely by the returns he is likely to get on his investment on fertilisers. A favourable benefit cost ratio is, therefore, a crucial factor in the development of fertiliser use. According to experts, if there is to be ready acceptance and extensive use of fertilisers and other yield-increasing practices, then the value of increased production must exceed the cost of fertiliser by 2·5 times. Effective demand for fertiliser is considered weak if the value of additional output is less than twice the cost of fertiliser; it is strong when the ratio is in the range of 2·0 to 2·5; and it is very strong when the relationship exceeds 3·0. Substantial improvement can be brought about in the benefit/cost ratio by increasing the value of the benefits or by lowering the cost of fertilisers (and other inputs) or by doing both.

Measures to increase the benefits of fertiliser use may be categorised under economic measures and technical measures. Among important economic measures can be listed the following :—

(*i*) the fixation and operation of support prices and procurement prices of grains.

(*ii*) freedom to market produce in any part of the country; and

(*iii*) a forward looking policy for developing an adequate infrastructure in respect of transport, roads, warehouses, regulated markets, etc.

Some of the important Technical measures to increase the benefit of fertiliser use can be :—

(*i*) the development of high-yielding disease resistant fertiliser-responsive, water economising varieties of seeds by intensive plant breeding work;

(*ii*) minimization of damage by diseases, insects, rodents etc in the field and in storage;

(*iii*) regulation of fertilizer application by soil test;

(*iv*) expansion of irrigation facilities;

(*v*) soil and moisture conservation techniques; and

(*vi*) improving the farmers' efficiency through education and technical advice.

Benefits of the fertiliser use can also be increased by reducing the price of the fertlilizer. Prices of nitrogenous fertilisers in India are very high as compared to the prices in other countries. This disparity becomes all the more significant because nitrogenous fertilisers constitute the bulk of fertilizer consumption in India. During the year 1967-68, the price of one quintal of ammonium sulphate was $ 37·1 in India as against 17·9 in U.K., $ 21·7 in Pakistan, $ 25 6 in Japan, $ 26 9 in Australia and $ 28 8 in U.S.A.

The benefits of fertiliser use in a country cannot, however, be determined exclusively by the level of fertilizer prices without taking into consideration the prices of farm products also. Despite higher prices, the consumption of fertilisers in a country will continue to rise if the prices of farm products in that country also display commensurate increases. With a view to having a clear idea about the benefit of the fertiliser use, therefore, the price of fertiliser should be worked out in terms of the farm products, as may be seen from the table below :—

Relative position of the prices of Wheat, Rice & Fertilisers

1967-68

| | *Kg. of wheat for 1 Kg. of* | | | *Kg. of rice for 1 Kg. of* | | |
|---|---|---|---|---|---|---|
| | *N* | $P_2O_5$ | $K_2O$ | *N* | $P_2O_5$ | $K_2O$ |
| | 1 | 2 | 3 | 1 | 2 | 3 |
| 1. Australia | 3 96 | 1·90 | 1·71 | — | — | — |
| 2. Belgium | 2·84 | 1·83 | 0·84 | — | — | — |
| 3. Canada | 5 10 | 3·98 | 1·72 | — | — | — |
| 4. France | 2·53 | 2·18 | 0 85 | — | — | — |
| 5. F.R.G. | 2·65 | 2·26 | 0·77 | — | — | — |
| 6. Italy | 2·55 | 1·57 | 0·98 | 2·33 | 1·44 | 0 90 |
| 7. Japan | 1·75 | 1 64 | 0·66 | 0 71 | 0·66 | 0·27 |
| 8. Netherlands | 2·83 | 2·38 | 0 94 | — | — | — |
| 9. Pakistan | 1·43 | 1·70 | — | 0 98 | 1 16 | — |
| 10. Taiwan | — | — | — | 2·79 | 1·54 | 0·82 |
| 11. U.A.R. | 4·90 | 3·02 | 1·85 | 1·80 | 1·11 | 0·68 |

| | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| 12. U.K. | 2·75 | 2·32 | 1·40 | 0·73 | 0·62 | 0 37 |
| 13. U.S.A. | 5·65 | 4·55 | 1·92 | 1·55 | 1·25 | 0 53 |
| 14. India | 3·12 | 1·90 | 0 62 | 3·20 | 1·95 | 0·64 |

Source : The Fertilizer Association of India

N—Sulphate of Ammonia $P_2O_5$—Superphosphate
$K_2O$—Muriate of Potash

The price at which fertiliser is delivered to the farmer includes the cost of production of fertiliser and the cost of marketing it. There appears to be some scope for the manufacturers in India to effect reductions in costs by having recourse to economies of scale, improved technology, more efficient management, etc. As regards marketing component in the farmers' price, there does not appear to be much scope for effecting economies.

## PRODUCTION

So far in India, the production of fertilizers has been trailing far behind the tragets fixed in this regard from time to time. As against the production target of 383 thousand tonnes of Nitrogen set for the Second Plan period, the actual production was only 112 thousand tonnes. For the Third Plan period, the production target for Nitrogen was set at 800 thousand tonnes, but the actual production was only 238 thousand tonnes The production target of 800 thousand tonnes of Nitrogen set for the year 1965-66 was not achieved even in 1969-70 when the production was estimated at 750 thousand tonnes only.

The Fourth Plan consumption target for 1973 74 has been set at 3·2 million tonnes of Nitrogen and 1·5 million tonnes of $P_2O_5$. On the basis of the number of factories in production and the projects under construction, the actual production by 1973-74 is, however expected to be around 2·0 million tonnes of Nitrogen and 0·6 million tonnes of $P_2O_5$. The excess of the demand for fertilizers will have, therefore, to be met through imports of fertilizers, as heretofore.

During 1967-68, India had accounted for about 14% of the

world imports of Nitrogenous fertilizers, about 6% of the imports of $P_2O_5$ and about 2% of the imports of $K_2O$. The actual proportion of imports in the total consumption of fertilizers in India is given in the table below :—

**Production and Imports of Fertilisers***

| *Year* | *Total production* | *Imports* | *Imports as% of Production* |
|---|---|---|---|
| | (Thousand tonnes) | | |
| 1965-66 | 89 | 64 | 71 |
| 1960-61 | 166 | 197 | 119 |
| 1965-66 | 357 | 492 | 138 |
| 1966-67 | 455 | 847 | 186 |
| 1967-68 | 610 | 1,623 | 266 |
| 1968-69 | 776 | 1,036 | 134 |
| 1969-70 | 935 | 766 | 82 |

*Fertilizers included are Nitrogen (N), Phosphates ($P_2O_5$) and Potash ($K_2O$).

Source : Fertilizer Association of India.

As a result of the poor performance under our fertilizer production programmes in the early years, it will not be possible during the Fourth Plan period to meet the fertilizers consumption requirements from out of the indigenous production only. A capacity of 3 million tonnes of Nitrogen has been proposed for the Fourth Plan period, but the achievements in this regard are expected to be around 2·2 million tonnes only. With the capacity of 2·2 million tonnes, the actual production will, at best, be only 2 million tonnes in 1973-74. The execess demand over this 2 million tonnes will have to be met through imports. It may, however, become possible to progressively reduce our dependence on imported fertilizers from 1975-76 onwards by realising increases in the indigenous production of fertilizers.

A rapid increase in the production capacity of Nitrogenous and Phosphatic fertilizers poses problems which are of a rather complex nature. The problems relate to raw material supplies, capital invest-

ments of a very large order, the availability of foreign exchange, the acquisition of know-how and technical collaboration etc. To achieve self-sufficiency in fertilizers, even by the end of the Fifth Plan, would require concerted efforts on the part of the Government and Indian entrepreneurs for tackling these problems.

The progress of the fertilizer production programme in India has suffered greatly for want of adequate and timely allocation of foreign exchanges. To attract foreign capital, significant changes in the Government's fertilizer policy were announced in 1965. But, this did not benefit the fertilizer industry in so far as the investment of foreign capital isconcerned. Efforts for securing foreign credit through international financial institutions and other sources also did not result in much success. It was only towards the end of the sixties that the hopes of attracting foreign capital investment in India's fertilizer industry were found to be ill founded and a policy of self-reliance was resorted to in this regard.

Natural gas is the most economic and convenient raw material for the production of nitrogenous fertilizers, followed by naphtha. India's proven natural gas resources have already been practically earmarked for Nitrogen production. The available surplus naphtha from the petroleum refinery programme has been fully allocated for Nitrogen and Petro-Chemical Production. India's further expansion of the Nitrogen production capacity must, therefore, depend on heavy stocks from the petroleum refineries and coal, unless India's oil exploration programme results quickly in substantial discoveries of crude oil and natural gas. The investment and operating costs of utilising heavy stocks and coal are higher than naphtha and natural gas; but, there is no alternative but to accept this position and relatively higher-cost products. The alternatives of imports of liquid ammonia and/or import of naphtha have to be ru'ed out on account of the heavy recurring foreign exchange expenditure and limited possibilities of production of suitable fertilizers with imported ammonia.

India's phosphate industry is exclusively dependent on imports. The raw materials — rockphosphate and sulphur are both imported, costing nearly £ 100 per tonne of phosphatic fertilizer (in terms of $P_2O_5$) which accounts for nearly 80% of the production costs. Except-

ing 'Trombay' and 'Hindustan Zinc', all other factories depend on imported raw materials.

India's requirement of $P_2O_5$ will be around 1·5 million tonnes by 1973-74. For meeting these requirements, India will be importing an intermediate product of phosphoric acid for a total of 0·23 million tonnes of $P_2O_5$. Arrangements for the remaining production of 1·27 million tonnes of $P_2O_5$ will have to be made separately, which would require 4·2 million tonnes of phosphate rock per year. On the basis of techno'ogy currently adopted in India, this production would also involve import of nearly 1·27 million tonnes of sulphur.

For achieving self-sufficiency in the production of fertilizers in the country, re-orientation of policy is needed both in respect of indigenous development of raw materials and adoption of newer technologies. According to preliminary studies, the deposits of phosphate rock of Jamakotra near Udaipur are estimated around 100 million tonnes, of which 11 million tonnes have been proved, 30 million tonnes appear to be reserves of relatively high grade rock and another 60 million tonnes are low grade rock requiring benefication for use. Work on Saladipura Pyrites also, if expedited, and a mining project completed for implementation, could solve the raw material problem to some extent.

There is great need for introducing changes in the production technology. The emphasis on use of imported sulphur in production of phosphatic fertilizers has to be changed and processes based on nitric acid decomposition of phosphate rock adopted, in order to eliminate, or, to reduce the need for import of sulphur. The production of soluble fertilizer phosphates can be most economical through the use of nitric acid. This process produces complex fertilizer containing essentially both forms of nitrogen and phosphates, i.e. both Nitrate-Nitrogen and Ammoniacal-Nitrogen and water-soluble phosphate and citrate-soluble phosphates. The production processes are integrated and contribute to economies in production process and distribution. Thus, the Ammonium Nitrate-Phosphate type of Nitrophosphates should be the preferred choice for India. Also, import of sulphur for production of phosphatic fertilizers should be banned unless limited quantities are required to supplement the requirements for production plans based primarily on Nitric Acid.

Towards the end of 1970, the Government of India decided to set up three coal-based fertilizer plants at Telchar in Orissa, Ramagundum in Andhra-Pradesh and Korba in Madhya Pradesh. Besides, clearance was given for Tata's proposal to set up a fertilizer project at Mithapur in Gujarat. The Mithapur plant alone will produce 850,000 to 900,000 of high analysis fertilizers. Taking into account also the proposed plant at Goa to be constructed by the Birlas, it can be reasonably hoped that the country will become self-sufficient in fertilizer by 1977.

An important problem needing attention in India is the extremely low consumption of phosphatic and potash fertilizers as compared to the consumption of Nitrogenous fertilizer. The ratio in which N, P and K are consumed in India is about 8:2:1 whereas the ratio considered desirable for India is 8:4:2 and the world ratio is about 8:8:8. The relative deficiency in the consumption of phosphatic and potash fertilizers exists despite their higher rate of growth of consumption as compared to that of the Nitrogenous fertilizer. Special efforts, are, therefore, needed for raising the consumption of phosphatic and potash fertilizers in the country through balanced doses of $N$,$P_2O_5$ and $K_2O$.

Increasing the production of fertilisers will not be enough for achieving the desired increases in fertilizer consumption in India. Much will have to be done to educate the farmers and to bring the fertilisers within their easy reach. It is essential to evolve and put into operation an easily accessible and up-to-date advisory system, an effective and integrated distribution system and also a sound credit system for both distribution and production.

For suggesting ways and means for the promotion of fertilizer use in India, a Committee was appointed by the Government of India in 1969, under Shri B. Sivaraman. One of the major recommendations of the Sivarman Committee on Fertilizers was that a Fertilizer Promotion Corporation should be set up to undertake, among other things, intensive basic educational promotion of fertilizer use on a country-wide basis, with a view to supplementing the

efforts of the established extension agencies of the State Departmenets of Agriculture. After several vicissitudes, the proposal now seems likely to take shape in the immediate future, in the form of a joint-venture of the Central Government and the Fertilizer Industry. It was proposed to finance the proposed Fertilizer Promotion Council partly by grants from the Government and partly by funds raised by a cess levied on each ton of fertilizer sold.

# 7

# Plant Protection

In the New Agricultural Strategy, plant protection measures have acquired great significance. This is due to both technical and financial reasons. In the case of high-yielding varieties, as also the multiple cropping programme, conditions which are conducive to the growth of the plant population are also favourable for weeds, pests and diseases. Moreover, the high-yielding varieties necessarily entail a high cost of cultivation and, hence, a cultivator can ill-afford to lose even a part of his crop.

## SCOPE AND SIGNIFICANCE

Crops as they grow and crop products in storage, are liable to suffer damage through pests and diseases. Plant Protection is the adoption of measures to prevent such damage, or to arrest, minimise or obliterate it, once it has occurred. The prevention or repair of damage to seeds, crops and crop products caused by frost, flood, drought, poor soil, water-logging, heat, sun, rain or moisture, as such, is not plant protection While a crop may be made to recover from the effects of damage by pests and diseases, damage to a crop product can only be arrested but not repaired.

Successful agriculture is impossible even in the simplest form, without effective plant protection measures. With the growing application of science and technology to farming, the need for the control of plant pests and diseases becomes all the more imperative.

This is so because new crop varieties, new cropping patterns and the lush growth of plants induced by the use of balanced fertilizers and judicious irrigation, usually invite pests and diseases and condition the soil for the growth and development of a variety of fauna and flora, many of which prove injurious. In the absence of plant quarantine measures, the movements of plants and plant products in international trade and traffic also carry risks of accidental introduction of plant pests and diseases into the importing country. The function of plant protection is to prevent or remedy situations in which pests and diseases may damage crops or crop products.

Rapid changes in crops and varieties, necessitated by adoption of various high-yielding varieties and multiple cropping programmes throughout the country, have thrown up a host of new problems. With liberal use of fertilizers, multiple and relay cropping etc., insects, diseases and weeds tend to proliferate quickly. These changes have led to widespread occurrence of not only old insect pests and diseases, but also of rela ively minor and newer ones assuming disastrous proportions. The growing of Taichung Native I, particularly during *Kharif* season, simultaneously led to the appearance of a minor bacterial disease in epiphytotic form all over the country. During 1969, *jassids* in epizootic form appeared over vast tracts extending through West Bengal, Bihar, U.P., Madhya-Pradesh and Orissa, and threatened the cultivation of even the well-adapted local varieties of rice. In 1967, the growing of hybrid *bajra* in low-lying areas created the epiphytotic of *ergot* disease in Rajasthan, Haryana, Punjab and in certain parts of Uttar-Pradesh. During 1968 and 1969, *Pyrilla* on sugar-cane and wheat created an unprecedented situation in three northern states of Punjab, Haryana and Uttar-Pradesh. It is hardly possible to grow hybrid sorghum without adequate plant protection measures against *shoot fly*. It is also likely that insects and diseases may become a limiting factor in the spread of hybrid maize. The introduction of dwarf varieties of wheat like Kalyansona, Sonalika, Sonora-64 and Lerma-Rojo have brought into prominence such minor diseases as *leaf-blights* in Uttar-Pradesh, Haryana and Punjab. During the 1969 rabi season, the wheat crop was reported to have been attacked by *foliage blight* in as many as 40 districts of U.P.

and by *cut worms* and *army worms* in Madhya-Pradesh and Bihar. During 1970-71, incidence of pests and diseases was reported from parts of Andhra-Pradesh, Maharashtra, Madhya-Pradesh, Mysore, Orissa and Tamil-Nadu. If the potential for higher yields on account of increased use of fertilizers is thus allowed to be nullified by pest attacks, this will not only affect production but will also retard fertilizer consumption because of the fear of pests and diseases swallowing a sizable proportion of the production.

Total loss due to pests and diseases in India was estimated around 20% of the crops in 1965, and was probably of the same order in 1970. That the losses due to pests and diseases continue to be of about the same order in spite of the expansion of plant protection activities all over the country can be attributed to several factors. An important reason mentioned in this regards is that plant protection problems have multiplied with the development of plant protection measures. But, an equally important reason is that the plant protection measures have not been practised effectively and adequately. The responsibility for this low rate of adoption of plant protection measures lies with the plant protection organisations and various agencies and services — agricultural, administrative and others, which are responsible for the efficient functioning of various plant protection activities.

The tempo of the 'Green Revolution' in the country cannot be sustained without an appropriate improvement in the plant protection activities. All efforts for increasing the agricultural production in the country without adequate plant protection measures, will only mean creation of ideal breeding grounds for a wide range of pests and diseases which will devour a bulk of the anticipated agricultural production and cheat the farmers of their investments. Mere increase in crop production is not enough; suitable ways and means have also to be devised for preserving the produce till it is required for processing/consumption.

The farmers' stake in the crops increased with higher investments and yield rates. This provided the much needed fillip to the plant protection activities in the country. Even in low rainfall and

dry areas, the crop protection assumed an important role in maximising yields. As a result, the gross coverage under plant-protection measures increased from 17 million hectares at the end of the Third Plan to 40 million hectares in 1968-69 and to 52 million hectares in 1970-71.

The plant protection measures also help to maintain the quality of the crop produce and, thus, add to its market acceptability and monetary value. Other factors being favourable, the plant protection measures enable a crop to yield its maximum within the limitations of its environment. The loss sustained in the absence of these measures is not merely that of reduction in yield or deterioration of the produce, or both, but also that of wastage of land, labour and resources expended in growing the crop, to the extent that the benefit falls short of expectations. Another loss, generally not appreciated, is the missing of an opportunity to produce the maximum and best yield from a crop when it is economically most wanted. Well-planned and well-executed plant protection measures make it possible to achieve the same yield from a smaller area of land, and with less labour and expenditure than would be the case otherwise. Plant protection measures not only increase agricultural production, but, also facilitate economy in the use of resources, which can be transferred and channelised into other beneficial uses.

The role of plant protection is not only to keep a crop in good health and the crop produce safe in storage, but also to create and sustain conditions under which plant pests and diseases will not spread and multiply. This implies use of both direct and indirect methods. The direct methods include operations like spraying and dusting with pesticides, seed treatment, fumigation, biological control, use of irradiation to kill eggs, larvae, pupae and adults of pest insects in storage etc.

The chemical or other treatment of agricultural commodities on arrival at plant quarantine stations is a direct method employed to eliminate risks of pests and diseases spreading into new areas. The destruction of the desert locust, specially in its breeding grounds, is also a direct measure to save crops in areas far removed from the scene of destruction.

The indirect methods include the prevention of the accidental introduction and spread of new plant pests and diseases into areas where they did not exist before. The indirect method, therefore, can increase production by preventing damage by pests and diseases, even though the impact of the methods on production cannot be quantitatively assessed. The introduction of water hyacinth (*Jal kumbhi*), woolly aphis of apple and wart disease of potato into India has been responsible for considerable economic damage and also for much labour and expenses in controlling them. The water hyacinth was introduced not accidentally, but deliberately around 1891, as an ornamental aquatic plant.

The plant protection measures have, as their aims, both prevention as well as cure of the plant diseases. However, even with the best of the preventive measures, the need for curative treatment always remains, because prevention can only be designed against something which can be anticipated and also because no preventive method is perfect. The appearance of plant pests and diseases depends on so many diverse factors and despite all precautions, they cannot always be avoided. While a mistake made in the direct control of plant pests and diseases can be discovered within days of the treatment applied, and its result is usually confined to the areas of the treatment, defectively designed preventive measures may show up their harmful results only after years of futile activity, and their effects can be widespread.

## PROGRESS

The progress of plant protection measures in India has been rather slow in the beginning. It was in the year 1946 that the Central Plant Protection Organisation was set up, followed by the similar organisations at the state level. The coverage during the First and Second Plan periods was 2·4 and 6.4 million hectares respectively. Subsequently, the area covered increased to 17 million hecatres at the end of the Third Plan and to 52 million hectares in 1970-71.

The Fourth Plan has set a target of 80 million hectares to be covered by the Plant Protection measures by 1974. Separate

targets for the various measures are as under :

| *Measure* | *Area to be covered (in Million hectares)* |
|---|---|
| 1. Seed treatment | 26 |
| 2. Weed Control | 2 |
| 3. Intensive treatment | 34 |
| 4. Pest control | 8 |
| 5. Rat Control | 10 |
| Total :— | 80 |

Seed treatment is the first crucial stage of plant protection. Dressing the seed with chemicals before sowing protects the seed from the seed and soil borne diseases and is essential for increase of plant population which is responsible for raising the yield potential of the crops.

Weeds are the persistent, unwanted and often prolific plants which reduce yields, increase cost and compete with food and fibre plant for water, sunlight and soil nutrients. Weeds harbour disease organisms that attack desirable crop plants and provide nesting places for wild rodents and undesirable birds. Some of the weeds are poisonous and, therefore, dangerous for life. When weeds infest irrigation tanks and canals, water flow is seriously impeded. Weeds also interfere with the application of insecticides and fungicides. Weed control through manual labour has obvious limitations in high density crops. Hence, there is need for laying more stress on chemical weed control measures.

Post-sowing intensive prophylactic treatment constitutes the main plank of the plant protection programme in India. In order to be effective, this programme requires two main supporting measures. The first relates to the organisation of a surveillance and warning system The second one concerns intensive research on determination of the most effective chemical control measure for various pests and diseases.

Effective adoption of plant protection measures on the part of

the cultivators is often inhibited by two among other factors, namely, lack of technical skill in the use of pesticides and ineffectiveness of individual operations. In this context, Fourth Plan envisages a strengthening of the official plant protection services and expansion of training facilities. Steps are also proposed in the Fourth Plan for strengthening of the Agro-aviation arrangements, both in the public and private sectors. In the endemic areas, repeated aerial spraying is envisaged for eradication of pests and diseases. Such spraying is proposed to be financed by the centre while the cost of the material will be borne by the states.

Unlike chemical fertilizers, the plant protection material is still largely distributed by official agencies. It is estimated that at present about 60 percent of the material is handled by Govt. personnel. Cooperatives and panchayats account for about 25 percent and the balance is retained by private dealers and manufacturers. It is estimated that by 1973-74, the annual consumption of pesticides should go up to 66,000 metric tonnes of technical grade material as against the present annual consumption of 40,000 metric tonnes.

Concerted efforts have to be made in order to ensure adequate and timely supply of pesticides and plant protection equipment to the farmers so that all the programmes are implemented successfully. Some 36 pesticides are now produced in the country in as many as 70 plants with total installed capacity of about 70,000 tonnes. This is considered sufficient to meet the Fourth Five Year Plan requirements. In fact, the consumption of pesticides has not grown to the expected level, with the result that some of the installed indigenous capacity has remained unutilized. There are over 120 formulating plants/units in the organised and small scale industries sectors with an installed capacity of 1,65,000 tonnes of different formulations viz. dust, water dispersible powder, emulsion concentrate, solution, granules slurry, aerosol, etc. The distribution channels for pesticides are required to be further expanded and streamlined.

The local production of hand and power-operated plant-protection equipment has made considerable progress recently and about 2 lakh pieces of former and about 30,000 of the latter are produced

annually to meet the demand in full. There are also plans for introducing better and more effective chemicals and epuipment for plant-protection work in the country. To ensure supply of quality plant-protection input, the Indian Standards Institution have prepared over 80 standards for pesticides and 12 for plant-protection equipment.

Out of the various methods, chemicals have proved to be the most effective and have received, by far, the greatest attention. However, the full benefits of chemicals could not be realised because of their being generally applied on standing crops after the appearance and development of pests. Recently, there has been a tendency for the adoption of protective measure, as a result of extension work. In the Intensive Agricultural Districts Programme, notable progress in adopting prophylactic measures for insects pests and diseases has been made and this change in outlook has to be fully exploited as the prophylaxis hold the key to success in plant protection. It is both economical and effective, and provides a real and cheap insurance for the crop. A good example of beneficial effects of prophylaxis is the treatment of seed before planting. In India, a large quantity of seeds is now being treated with fungicides like *captan thiram* and *organomercurials*. A very high benefit/cost ratio ranging from 10 to 45 is observed in the case of seed treatment.

In standing crops, the preventive sprays/dusts are used to control a wide range of pests. The benefit/cost ratios which vary according to crop-pest combination, are generally of lower order, but confer large financial returns to justify application. The need at present is to develop compounds to economize on the materials and number of applications. With the advancement in research and technology, the concept of tailor-made pesticides is now becoming a reality. The availability of better materials like carriers, stickers, spreaders and emulsifying agents has greatly helped in the production of better formulations with built-in increased persistence and efficacy.

The conventional method of distributing dilute solution/suspension of pesticides through spray nozzle at a high rate (400-500 litres), is now regarded both wasteful and time-consuming. The present trend in crop spraying is to apply more concentrated pesticides in 40

to 100 litres by means of low-volume sprayers. This has been made possible through the development of better formulations and special nozzles. A good example of the twin effort is the successful application of oil-based copper fungicides from air, for controlling secondary leaf fall disease of rubber in South India.

A new revolutionary technique of aerial spraying using only ½ kg. per hectare of concentrated pesticide without the use of water, tried for the first time in India in 1965, is becoming popular. The wider application of this technique against a large number of pests is, however, limited, due to non-availability of suitable pesticides. *Malathion LVC* has been the only pesticide cleared for undiluted application from air, because of its relatively safe nature for human beings and warm-blooded animals. This is a real challenge to the industry for producing safe materials for ULV application. A nozzle has also been developed for ULV application, using motorised ground equipment. It is now possible to cover larger areas in the shortest time, which is of great significance in fighting out epidemics.

The work relating to surveillance of insect pests and diseases has assumed a greater significance in recent years because of the occurrence of frequent and widespread epidemics of various insect pests and diseases in many countries. In India, however, this has only been attempted with desert locust. The Directorate of Plant Protection, Quarantine and Storage has accumulated, over the years, some useful data on the incidence of insect pests and diseases through the net-work of its Regional Stations. Some basic data is also reported as available at the Commodity Research Institutes. There is an urgent need to sift these data to establish some guidelines and to find out the gaps in our knowledge for future work. To Make prophylaxis more realistic and economical, there is an urgent need to initiate reporting and improve surveillance work in the country.

Regulatory measures have a particular significance in plant-protection. While, in most cases, the control operations have to be adopted voluntarily by the cultivators; at times, it becomes necessary to use compulsion when larger areas are threatened. Most of the states have modified/enacted Pests and Diseases Act on the lines

of the model Pests and Diseases Bill prepared by Govt. of India. These Acts empower the executive to notify potentially dangerous and destructive pests, plant diseases and obnoxious weeds, and provide for action to be taken by the farmers on community-wide basis, collectively. For obtaining better results, the endemic areas of insects and diseases occurrence in different parts of the country require to be marked out for organising concerted campaigns.

For keeping out the exotic insect pests, plant diseases and obnoxious weeds, the existing Destructive Insects and Pests Act has been modified from time to time. The Insecticide Act passed in 1968, regulates import, manufacture, transport, storage, sale and use of pesticides with a view to preventing risk to human health, cattle, wild-life and fish, etc. through contamination of environment.

For effective implementation, a strong training support for the plant-protection organization is very important. Such a training is being imparted by a specialised all India Institute, closely linked with the organisation dealing with practical and day-to-day problems of plant-protection. The people trained by the Institute give training to other people in the states. The need for plant-protection personnel at all levels, to keep abreast with the latest information, techniques and procedures has increased manyfold due to the rapid introduction of new pesticides, their newer formulations and more sophisticated application techniques for insects and diseases control on the one hand and new pests and diseases problems created by changing cropping patterns on the other.

## PROBLEMS

Despite remarkable progress in plant-protection during the last decade, there are a number of problems requiring interdisciplinary approach in research and development. Some of these problems are :—

(*i*) Need for more specific, less persistent pesticides with low mammalian toxicity.

(*ii*) Need to have better formulations of water dispersible powders. granules, combination pesticides, fertilizer pesticide mixtures and also the equipment to apply these.

(*iii*) Compulsory seed treatment and greater attention to weed and rodent control.

(*iv*) Aero-chemical protection in endemic areas on prophylactic basis.

(*v*) Development of insect pests and plant diseases surveilllance *service on regional/national basis.*

(*vi*) Adoption of integrated pest control measures.

# 8

# Multiple Cropping Programme

Growing of three or more crops in a year, on the same piece of land is called multiple cropping. India has a net cropped area of 137 million hectares and a gross cropped area of 157 million hectares. There are, thus, 20 million hectares of land in the country which gives more than one crop in a year. This additional cropped area of 20 million hectares in a net croped area of 137 million hectares means a cropping intensity of 114 per cent only. Certain other countries, with comparable conditions, have much higher cropping intensities as may be seen from the table below :—

| *Country* | *Cropping Intensity (per cent)* |
|---|---|
| 1. Taiwan | 180 |
| 2. South Korea | 151 |
| 3. Pakistan | 137 |
| 4. Japan | 120* |
| 5. India | 114 |

India's cropping intensity which was 114 per cent in 1966-67 was arourd 118 per cent in 1970-71. This indicates very little progress in view of the large extension in agricultural facilities made during the planning era. That there has not been any substantial improve-

*The cropping intensity in Japan was 144 per cent in 1956, but declined to 120 per cent on account of diversion of lands to orchard crops.

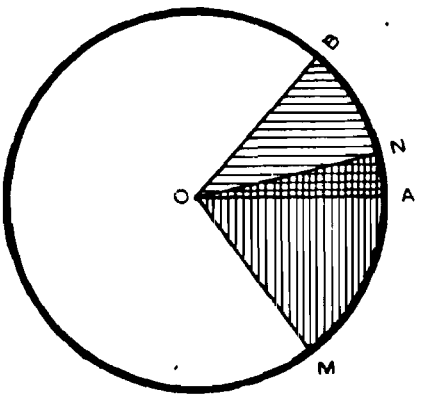
ment in the cropping intensity in India over the last 15 years can be seen from the table below :—

(*Million hectares*)

| | 1950-51 | 55-56 | 60-61 | 65-66 | 66-67 |
|---|---|---|---|---|---|
| 1. Gross cropped area | 131·89 | 147·31 | 152·72 | 155 33 | 156·69 |
| 2. Net cropped area | 118·75 | 129·16 | 133·16 | 136·14 | 137·08 |
| 3. Area cropped more than once | 13·14 | 18·15 | 19·56 | 19·19 | 19·61 |
| 4. Intensity of cropping | 111·0 | 114·0 | 114·7 | 114·0 | 114·4 |

**Scope & Significance**

Abundance of water supply is one of the essential pre-requisites for the success of the multiple cropping programme. The diagram given below is a graphic description of the position. It will be seen from the graph that out of the 20 million hectares on which more than one crops are raised (BOA), only 5 million hectares have more than one irrigated crops (NOA). Also, out of the 28




Net sown area = 137 M. Hectares
Area sown more than once = 20 M. Hectares (BOA)
Irrigated Area = 28 M. Hectares (MON)
Double Cropped area with Irrigation = 5 M.Hectares (AON)

million hectares of irrigated land in the country (MON) about 5 million hectares (AON) is irrigated more than once. The irrigational facilities in the remaining 23 million hectares of land (MOA) irrigate only one crop in a year. It can be seen, therefore, that the contribution of irrigation to multi-cropping in India is very little (AON) and a very large proportion of the double cropped land lies in the rainfed areas (BON). It may, therefore, be possible, and also more profitable, to utilise the single cropped irrigated lands (MOA) for the extension of the multiple cropping programme.

With a view to raising the cropping intensity, the Government of India initiatiated in 1967-68, the Multiple Cropping Programme as a part of the New Agricultural Strategy. Against the target of 3 million hectares set for the year 1967-68, the actual coverage was about 4 million hectares. For the year 1968-69, a target of 6 million hectares was fixed for the Multiple Cropping Programme. A centrally sponsored scheme for organising 51 multiple cropping pilot projects had been taken up during the year 1970-71. During the first two years of the Fourth plan, about 3 4 million hectares were added to the gross cultivated area as a result of the efforts to increase multiple cropping.

During the Fourth Plan period, an additional area of 9 million hectares is proposed to be covered, making an aggregate of 15 million hectares under the Multiple Cropping by the end of the Fourth Plan period. During 1970-71, however, the area under multiple cropping had risen to about 9·5 million hectares only. The implementation of the programme is proposed to be undertaken in the light of the following guidelines :—

(*i*) Crops grown in succession should not be susceptible to the same disease and pests :

(*ii*) There should be a leguminous crop in the rotation so that biological nitrogen fixation is promoted ;

(*iii*) Crops grown one after the other should have different rooting patterns so that one crop takes nutrients from the upper layer of the soil while the other taps the lower areas ; and

(*iv*) Cultivation of the photo-insensitive and short duration varieties should be taken up for making fuller use of moisture available from late rains.

The launching of Multiple Cropping Programme on a big scale has been possible due mainly to the evolution of short duration high-yielding varieties which have raised the number of crops in a year and also introduced new crop rotations. Under the National Demonstration Programme, several new crop rotations have shown a significant increase in total production per unit of area and time. Barley, *ragi* (finger-millet) oilseeds, potatoes and vegetables have also been brought into crop rotations in addition to short duration varieties of rice, maize, *jowar*, *bajra* and wheat. According to the Fourth Plan, the multiple cropping programme will offer a potential for increase in production comparable to that provided by the High Yielding Varieties programme.

Some of the essential elements for the success of the programme are :—

(1) The selected area should have adequate irrigation and drainage facilities to permit intensive cropping. It should have about 40-50 per cent of cultivated area under irrigation. Preference may be given to areas where there has already been consolidation of holdings ;

(2) The selected area should be adequately served by service institutions such as cooperatives, commercial banks, supplies distribution firms etc ;

(3) The area should have suitable infrastructure needed for agricultural growth such as roads, marketing, warehousing and processing facilities, etc.

Tropical India has extremely favourable conditions for the success of the multiple cropping programme. In countries with temperate climate, the growing season for crops is short on account of the unsuitability of the temperature and daylength there In these circumstances the farmers can grow ordinarily only one crop a year and the production is sought to be increased by raising the yields per unit area. But India is a tropical country. and, therefore, neither the temperatures nor the daylength limits the crop growth. In spite of its favourable climatic situation, land in India

is actually used for crop production only less than half the year and, over large areas, land remains covered with useless vegetation most of the time. This underscores the necessity of making efforts for realising full use of the land through a more rational and intensive plan for land use.

Certain recent studies on farm management show that nearly a fourth of the family labour engaged in traditional farming does not get gainful employment because farm operations are not spread over the whole year. With regard to the bullock labour, the situation is still worse. Generally, the bullock labour is not used for any operation for about six months in a year. In the case of small farmers, the intensive multiple cropping would result in a better utilisation of family labour and bullock power resources. Besides, the employment opportunities for agricultural labourers will be greatly enhanced through intensive farming and related works-programmes for land-shaping and similar jobs.

For the small farmers, the Multiple Cropping Programme has a special significance. India is a country of small farm holders. About 63 percent of the farmers possess less than two hectares of land. A family of 5 to 6 and cattle population of 4-5 is generally maintained on these small holdings where the traditional pattern of single or double cropping prevails. The bulk of our small farmers have comparatively larger labour resources per unit of land and, would greatly benefit from the labour intensive cropping pattern.

During 1967-68, the U.P. Agricultural University Pantnagar, conducted field experiments in regard to five crop rotations of maize, lahi (ropeseed), wheat, cheena (common millet) and potato. The five crop rotations are described graphically on page 193. Economics of these different crop rotations is indicated below :—

| *Crop* | *Yield q/ha* | *Straw yield q/ha* | *Value of the produce Rs./ha* | *Cost of cultivation Rs./ha* | *Net profit Rs./ha* |
|---|---|---|---|---|---|
| 1. Maize | 43·23 | 252·00 | 2,414 | 1,059 | |
| Lahi | 19·50 | — | 2,633 | 570 | |
| Maize | 77·47 | 305·00 | 4,178 | 1,429 | |
| | | Total | 9,225 | 3,058 | 6,167 |

| | | | | | |
|---|---|---|---|---|---|
| 2. | Maize | 43·86 | 252·00 | 2,445 | 1,059 | |
| | Lahi | 18 31 | — | 2,472 | 570 | |
| | Wheat | 26·50 | 50·20 | 2,371 | 1,654 | |
| | Cheena | 35 50 | — | 1,420 | 750 | |
| | | | Total | 8,708 | 4,033 | 4,675 |
| 3. | Maize | 44·65 | 252·40 | 2,485 | 1,059 | |
| | Potato | 294·62 | — | 8,838 | 3,042 | |
| | Maize | 78·21 | 307·40 | 4,218 | 1,429 | |
| | | | Total | 15,541 | 5,530 | 10,011 |
| 4. | Maize | 43·96 | 253·10 | 2,451 | 1,059 | |
| | Potato | 286·01 | — | 8,580 | 3,042 | |
| | Wheat | 27·78 | 51 50 | 2,480 | 1,654 | |
| | Cheena | 34·00 | — | 1,360 | 750 | |
| | | | Total | 14,871 | 6,505 | 8,366 |
| 5. | Maize | 45·07 | 257·60 | 2,556 | 1,059 | |
| | Wheat | 56 61 | 80·50 | 4,931 | 1,654 | |
| | Cheena | 38 60 | — | 1,544 | 750 | |
| | | | Total | 9,031 | 3,463 | 5,568 |

Price of Maize @ Rs. 50/- q
Price of Lahi @ Rs. 135/- q
Price of Wheat @ Rs. 80/- q
Price of Potato @ Rs. 30/- q
Price of Cheena @ Rs. 40/-q
Price of wheat straw @ Rs. 5/-q
Price of maize straws @ Re. 1/- q

The salient features of the five different crop rotations are given below :

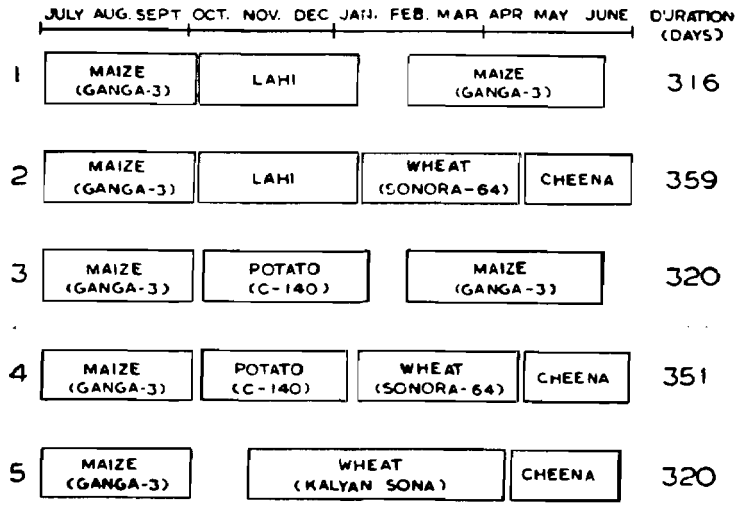
1. *Maize-Lahi-Maize*

Maize-*lahi*-maize is one of the popular rotations in the Nainital Tarai. All the three crops in the rotation are so well adjusted that all of them can be planted and harvested at the optimum time. The labour and other resources which are needed are also very well distributed throughout the year and no acute problem of resource allocation is experienced at any time.

2. *Maize-Lahi-Wheat-Cheena*

Maize-*lahi*-wheat-*cheena* is a highly intensive rotation with 400% cropping intensity keeping the field busy for about 359 days in a calendar year. The wheat crop in this rotation has been found to yield only 50% of the optimum with same cost of cultivation. Also, as only six days are available in this case for the field perparation and sowing of four crops included in the rotation, the labour and other energy requirements become limiting factors in its wide adoption. During the peak periods of harvesting and sowing, the requirements go beyond the normal resources of the farmer. Further, the net return per rupee invested in this case is only Rs. 1·16 which is lower in comparison with other rotations. This is due mainly to the yield reduction in wheat crop caused by late sowing.

**CROP ROTATIONS**




3. *Maize-Potato-Maize*

The maize-potato-maize rotation is found to be the most profitable one, giving a net profit of nearly rupee ten thousands per hectare with nearly two rupee net return per rupee invested. None of the crops in the rotation faces the problem of yield reduction caused by late sowing or immature harvesting. The rotation is most suited for the Tarai part of Uttar-Pradesh where the summers are mild and spring maize cultivation is successful.

4. *Maize-Potato-Wheat-Cheena*

Similar to maize-*lahi*-wheat-*cheena* rotation, this is also a highly intensive rotation. While in previous rotation a mid-late variety of potato can be used, in this case it is always advisable to use early duration variety of potato as *Kufri Chandra Mukhi* (A 2708). Early duration potato does not yield as high as the mid-late variety, but the higher prices prevailing during the early season may compensate for the yield reduction. Considerable reduction in wheat yield occurs due to late sowing.

5. *Maize Wheat-Cheena*

Maize-wheat-*cheena* is a rotation comprising all the foodgrain crops and having a very high grain production potential. This rotation can be very well adopted in Tarai and other parts of the state wherever irrigation facilities are available.

In a four-crops sequence cropping-pattern trial at the Indian Agricultural Research Institute, New Delhi, it was found that the highest total net income of Rs. 10,420 per hectare per year was obtained from *jowar*-radish-wheat-cowpea sequence, *jowar*-cauliflower-wheat-cowpea gave a net income of Rs. 8,383 and maize potato-wheat-cowpea gave a net income of Rs. 7.571 per hectare per year. Under relay cropping, which is a more sophisticated technique of multiple cropping, annual returns varying from Rs. 10,000 to Rs. 12 000 per hectare have been found possible on farms where inputs like water, fertilizers and labour are not scarce. A 400 per cent cropping intensity can yield a balanced production of 90 quintals of cereals, 10 quintals of high protein pulse grain, 150 quintals of nutritious legume green fodder and 9 quintals of oil-seeds. This may be seen from the rotations 'A' and 'B' given below :

| *Crop* | | *Value of the production Rs./ha* | *Cost of cultivation. Rs./ha* | *Net profit Rs./ha* |
|---|---|---|---|---|
| Rotation 'A' | Moong | 2,125 | 381 | |
| | Maize | 4,130 | 909 | |
| | Toria | 1,720 | 544 | |
| | Wheat | 5,425 | 1,281 | |
| Total | | 13,400 | 3,115 | 10,285 |

| *Crop* | | *Value of the prodution Rs./ha* | *Cost of cultiva tion. Rs./ha* | *Net profit Rs /ha* |
|---|---|---|---|---|
| Rotation 'B' | Moong | 2,125 | 381 | |
| | Maize | 4,130 | 909 | |
| | Potato | 4,120 | 1,652 | |
| | Wheat | 5,425 | 1,281 | |
| Total | | 15,800 | 4,223 | 11,577 |

Because of the lack of suitable technology, the production of pulses has been slowly declining. Pulses are grown on nearly 20 percent of the land used for foodgrains production and represent about 13 percent of India's foodgrains supply. It is a rich source of protein and forms an important part of indian diet. Short-duration varieties of pulses can very well be grown after the harvest of wheat or other *rabi* crops during summer months til· the monsoon rains arrive. *Moong* Baisakhi T 44 and T 2 (from U.P.) which mature in 65-70 days after sowing, or "*cheena*", common millet, which is of the same maturity period, could yield 1000 to 1500 Kgms. per hectare. From economic and scientific planning point of view also, a legume in the cropping system is more desirable.

Through a study of the effects of different rotations, including jute, on the yield of each crop, it has been found that a rotation of jute-rice-berseem is more economical and desirable. It gives a 250% cropping intensity and a total yield of 28·49 quintals per hectare of jute-filere, 37 quintals per hectare of rice and 598 quintals per hectare of fodder. In another study of multiple cropping of jute-rice-wheat, it was found that with a 120 to 135 days duration of jute varieties JRC-212, JRC-878,IR-8 rice and Sonora 64 wheat, it is possible to achieve a total yield between 130 to 133 quintals per hectare. In still another study of maximum production potential, it was found that annual production of 139 quintals per hectare could be achieved in a cropping sequence of jute-rice-wheat in 336 days, which comes to an average yield of 41·3 Kg. per hectare per day, as shown in the table on next page.

| Crop | Per hectare yield (Qtls) | No. of days | Per hectare per day yield (Kg) |
|---|---|---|---|
| 1. Jute (JRO-632) | 30·19 | 133 | 22·7 |
| 2. Paddy (IR-8) | 52·40 | 97 | 54·0 |
| 3. Wheat (Kalyan-sona) | 50·12 | 106 | 47·3 |
| Total | 132·71 | 336 | 41·3 (Average) |

## PREREQUISTES FOR SUCCESS

For a successful implementation of the multiple-cropping programme, serious consideration has to be given to the following :-

1. Water Management : If irrigation is to help grow double/multiple crops to a considerable extent, cropping pattern i.e. crops grown and technique of growing them have to be adjusted to water-regime and *vice-versa* such as :

(*i*) adjustment to an excessive water supply ;
(*ii*) protection from flooding ;
(*iii*) removal of surplus water from soil ;
(*iv*) an efficient use of water ;
(*v*) conserving surplus water for use in dry season :
(*vi*) use of supplemental irrigation during dry season at optimum cirtical stage of crop-growth ;
(*vii*) a better coordination among the Irrigation, Electricity and Agriculture departments, specially at the field level ; and
(*viii*) drainge.

2. Soil Management.

3. Need for flexibility of cropping pattern.

4. Need for mechanisation of small farms and introduction of custom service for timely and economical tillage, processing, plant protection and water management operations.

5. Need for thorough production-economics studies of various cropping sequences under various agro-climatic conditions.

6. Need for coordinated research studies on evolving crop varieties and economic cropping patterns in relation to climate-soil-

topography-inputs-market complex to find out common features for evolving future development plans.

7. Need for better organisation for timely and scientific assessment and evaluation of the statistics of the area sown more than once/multiple-cropped.

The high yielding varities are expected to be widely in use by the end of the Fourth Plan period when major gains through varietal break-through would have been nearly achieved. Further gains in agricultural production, during the Fifth Five Year Plan period would come mostly from intensive multiple cropping.

Although, some useful rasearch has been done for the various problems of multiple cropping, there is still much scope and necessity for more work to be done. The multiple cropping has been found to be a very potent multiplier factor in its effects on agricultural production and provides an opportunity to substantially increase both per capita and per hectare productivity of small farm holders.

# 9

# Dry Land Farming

The Fourth Plan has two main objectives in the agricultural sector. The first objective is to provide the conditions necessary for a sustained increase of about 5 per cent per annum during the seventies. The second objective is to enable as large a section of the rural population as possible, including the small cultivator, the farmer in dry areas and the agricultural labourer, to participate in the development process and to share its benefits. Accordingly, the agricultural development programmes fall broadly into two categories, viz.

(*i*) Programmes aimed at maximising production per unit area and time; and

(*ii*) Programmes aimed at remedying imbalances.

The programme relating to the dry land farming falls into the second category of programmes mentioned above. In the Fourth Plan, the dry land farming areas have been distinguished from absolutely arid or desert areas (with averave rainfall below 375 mms.) on the one hand and areas having a relatively assured rainfall of 1,125 mms. and above on the other. There are 128 districts in the country which have low to medium rainfall under 1125 mms. annualy and which also have very limited irrigational facilities. These districts account for nearly 68 million hectares or 1/2 of the net area sown in the country.

## SCOPE & SIGNIFICANCE

Out of the 128 districts of low to medium rainfall mentioned

above, 25 districts with a net sown area of about 18 million hectares constitute the very high intensity dry farming areas. These areas have a rainfall between 375 to 750 mms. and out of the 18million hectares, irrigational facilities exist in less than 1 million hectares only. Situated in central parts of Rajasthan, Saurashtra region of Gujarat and rain shadow region of western Ghats in Maharashtra and Mysore, these areas suffer from the maximum extent of instability in agricultural production and, therefore, present serious problems to tackle.

The typical dry land farming tract consists of 91 districts with an area of about 42 million hectares and lies mainly in Madhya-Pradesh, Gujarat, Maharashtra, Andhra-Pradesh, Mysore, Uttar-Pradesh, parts of Haryana and Tamil-Nadu. Out of the net sown area of about 42 million hectares of this tract, only about 5 million hectares are irrigated. A large part of this tract receives an annual rainfall ranging from 750 mms. to 1125 mms. These dry land farming areas hold good promise of responding to a new package of technology.

The remaining 8 million hectares of land in 12 districts, have irrigation in 3-4 million hectares of the cropped area and hence the the problem of these districts is no longer acute.

On the basis of a rather narrow definition of drought, *viz*, 'deficiency in rainfall, numerically equal to or greater than 25% of the normal' and the available data for the South-West Monsoons which account for 70% of the rainfall in the country, droughts should be expected over large areas once in 4-5 years. It can be as bad as once in 3 years in Telengana region in Andhra Pradesh, Madras, Gujarat, East Rajasthan, Kashmir and Uttar-Pradesh. The worst is west Rajasthan, where it may be once in 2½ years. Some of these areas are affected by prolonged dry spells which adversely affect the crop prospects.

Most of the dry areas are sparsely populated. The density of population per squire mile in most of the dry districts of the states of Andhra-Pradesh, Gujarat, Maharashtra, Mysore and Rajasthan is lower than that in the state as a whole. For example, the density in Kurnool is 207, while that in Andhra-Pradesh it is 339. Surendra-nagar district has density of 169 compared to that of 286 in Gujarat

state. In Jodhpur district the density is 102 while it is 153 in the whole state of Rajasthan. Similar is the case with most of the other dry districts. The contrast would become sharp if the density in these areas is compared with that in other irrigated or assured rainfall areas. In the state of Rajasthan, the density of population varies from 31 persons per square mile in an extremely dry tract to 146 persons per square mile and 155 persons per square mile respectively in the arid and semi-arid tracts. Probably, the population tends to adjust itself, over a period of time, with the capacity of the land to supply the food and fibre requirements of the people. The pattern of population density, it appears, gets adjusted, by and large, to the existing agricultural facilities and techniques in each area.

On account of the comparatively low density of population in the dry areas, the average size of holding there is larger as compared to that in other areas with better rainfall and irrigation facilities. However, the average size of holding generally varies from state to state, and within a state, from one region to another.

Foodgrains constitute the predominant production in most of the dry districts. Millets like Jowar, Bajra and to some extent, pulses, find an important place in the cropping pattern, though in certain areas, where soils are suitable, commercial crops like cotton, groundnut and sesumum are also grown. In some of the dry districts, where the quantum of rainfall is low and is also subject to wide fluctuations, farmers keep a high percentage of their cultivated area under drought-resistant, low-yielding and low-cost crops like inferior millets. In some of the areas, mixed cropping is a prevalent practice, probably to guard against wholesale crop losses, due to failure of rainfall or its uneven distribution,

The levels of yield per acre of most of the crops grown in the dry areas are generally very low compared to those in other areas of the same state or in other parts of the country which have irrigation facilities or better rainfall conditions. A significant feature of the agriculture in these areas is the wide variations in the yield of principal crops which introduces an element of instability into the economy of the region. In the very low rainfall or arid region, the

problem of instability caused by the variations in the yields of the major crops is more acute, as can be seen from table below:—

Yields of Principal Crops of Arid Region of Rajasthan.

*(1951-52 to 1966-67)*

| *Item* | *Principal Crops* | | | |
|---|---|---|---|---|
| | *Bajra* | *Kharif Pulses* | *Sesamum* | *Jowar* |
| Average Yield (Kgs./hect.) | 168·6 | 142·1 | 123·1 | 116·6 |
| Co-efficient of Variation | 32·5 | 22·0 | 47·2 | 42·7 |

Source:—Growth and Stability in Arid Agriculture by N. S. Jodha and V. S. Vyas, Agro Economic Research Centre, Vallabh Vidyanagar.

With the low and erratic rainfall, the generally dry weather conditions and the consequent instability in yield, the farmers so choose their crops that even under adverse weather conditions they get something to subsist on. The main objective of the farmer under such conditions is that of minimising the loss rather than maximising the profits.

In the day areas, the level of income of agriculturists and of all people in general, is generally low, except for certain industrialised pockets. This is attributable mainly to the peculiar situation of the low yields in agriculture and the high degree of instability in the economy. An idea of the relatively low level of income under dry farming, compared to that of farming under irrigated or good rainfall conditions, can be had from the data given below from the Farm Management Study carried out in Salem and Coimbatore districts of Tamil-Nadu.

**Out-put and Net Income per acre of different types of holdings**

*(1956-57)*

| *Type of Holding* | *Output* | *Input total cost* | *Net profit* | *Farm business Income* |
|---|---|---|---|---|
| | Rs. | Rs. | Rs. | Rs. |
| Fully Irrigated Holdings. | 640·7 | 433·9 | 206 3 | 399·3 |
| Partially Irrigated Holdings. | 198·9 | 170·1 | 28·8 | 96·3 |
| Fully Unirrigated Holdings. | 95·9 | 92·3 | 3·6 | 31·0 |

Some of the Village Surveys carried out by the Agro-Economic Reserch Centres have also shown that the level of incomes is very low in dry villages. For Example, the *per capita* income in 1962-63, in a dry village in Rajasthan (Sahnusar, Sikar district) was found to be Rs. 235 as against Rs. 475 in a wet village (Nanrangdeshar, Ganganagar district) in the same state. In Mysore State, the *per capita* income during 1955-56 was found to be Rs. 105 in a dry village (Jayapura, Mysore district) while it was Rs. 491 in a wet village (Mahadevpura, Nandya district). An Agro-economic study carried out in the arid and semi-arid regions of Rajasthan observes; "*bajari*" being a subsistence crop and having relatively higher yield, covers nearly 60 per cent of the cropped area. But the average yield is so low (168·58 kg./ha) that, when looked in the context of average size of land holding (about 6 4 hectares according to 1961 ecnsus) and prevailing price level of bajari, a desert farmer can hardly have the income sufficient for his family's sustenance even if he devotes whole of the area to bajari. The average yield in case of other principal crops is still lower as most of them (except sesamum) generally do not have prices higher than bajari. The low yield in case of sesamum may be partly compensated by higher prices it can fetch, but this crop shows high degree of yield variability. Moreover, in a subsistence agriculture, such a cash crop is bound to have lower preference. This is proved by the fact that only 5·72 per cent of cropped area was under sesamum".

Though the indebtedness of the cultivators in the dry areas is generally low compared to that of their counterparts in other areas, the relative burden is heavy for these cultivators because of their low level of incomes and the fluctuations in it from year to year. Under a situation characterised by low and fluctuating incomes, it may be just natural that these farmers find it hard to save and invest in agricultural improvements.

In the dry areas, because of the predominance of dry mono-crop culture and low intensity of cropping, one should normally expect that the annual labour requirements of crops would tend to be low and unevenly distributed. This would naturally lead to a situation of considerable under-employment of cultivating population. However, there are certain areas where this problem seems to be not so acute because the holding size happens to be relatively large in relation to the size of cultivating families.

An important socio-economic aspect which has a bearing on agricultural and overall economic development is the level of literacy of the people. The relevant data on literacy rate in some of the dry districts falling in the states of Andhra-Pradesh, Gujarat, Maharashtra, Mysore and Punjab are given in Appendix V. It may be seen from the data given therein that the literacy rates in most of these districts are relatively low, compared to the respective state averages. The position with regard to availability of schooling facilities seems to be no better. The relative under-development of these areas is also reflected in the transportation and communication facilities and in the development of institutions like cooperatives, etc.

The working of The New strategy based on the high-yielding varieties, which are confined mainly to irrigated or assured rainfall areas, is expected to accentuate the disparities existing between the incomes in dry areas and the incomes in irrigated areas. Further, with the widening of income disparities and the resultant social tensions, the need to find a suitable technology and to adopt other measures for improving the agriculture of dry areas requires hardly any re-emphasis. The provision of irrigation facilities, to the extent feasible, might help in reducing the instability and ensuring reasonable growth prospects for agriculture in some of these areas. But,

even, these efforts will leave uncovered a large part of areas dependent wholly on rainfall. It would, therefore, be necessary to evolve a suitable package of practices including the selection of appropriate type of seed etc. for these tracts. Given a suitable technology, which recognises the limitations of biological and natural hazards to which these regions are subjected to, and the necessary input supplies and institutional support, farmers in most of these areas would not be found wanting in their desire to improve agriculture. However, the type of technology that has to be developed may have to be different for the unirrigated and low rainfall areas on the one hand and the desert areas on the other.

Considering the fact that income levels in most of the dry areas are very low, it may be necessary to provide input supplies on subsidised basis, in order to induce the farmers to take to improved technology. Plant protection measures may have to be taken up on a community or area basis. These may have to be organised by Government through aerial spraying These areas may also need better credit facilities, as they move towards adopting a different type of technology. However, normal arrangements of providing credit would not meet the special requirements of these areas. In view of the inherent instability of the agricultural economy of these areas, there is need to provide credit on liberal terms, which may be recoverable not over a short period, but over a medium term. Since these areas are prone to extreme drought conditions, there is, probably, some need to protect the farmers against the risk arising out of the adoption of new technology which might involve a relatively larger volume of investment. The farmers may have to be helped to take up measures to conserve soil and moisture and for undertaking operations like land levelling, contour-bunding, consolidation of holdings, etc., on community basis. Another important measure that would be necessary to ensure the development of these areas is the provision of infrastructure, e.g , roads, communication facilities and marketing and storage facilities. These will have to be largely supported by governmental efforts.

Some of the dry areas, particularly in the states of Rajasthan, Haryana and Gujarat have already been practising mixed farming. In some of these areas, it has been found that livestock enterprises

give more stable income over a period of time as compared to crop enterprises. Such areas, probably, afford better scope for further development of dairying and animal husbandry activities. However, in the context of increasing pressure of population on land, it may not perhaps be immediately possible to release crop land from annual crops to pastures and grazing land. Once the country attains self-sufficiency in foodgrains, these areas might find it possible to reduce their land requirements for growing subsistence crops and for devoting more of these areas to growing fodders and for maintaining grazing lands on pastures. There is, however, considerable scope for undertaking livestock and poultry enterprises in most of the dry regions to supplement the crop enterprises, with a view to securing fuller utilization of available labour and to supplementing the farm income.

## PROGRESS

In the Second Plan, 45 Dry Farming Projects, covering about 400 hectares each, were taken up in different states and were extended through the Third Plan. These projects aimed at demonstrating the benefit of improved dry farming practices in low and erratic rainfall areas. The scope of these demonstrations included engineering measures like countour-bunding and terracing and agronomic practices relating to water conservation. These projects were reported to have achieved a limited measure of success only.

The Fourth Plan aims at making a significant impact on dry farming. The programme envisaged is two-fold viz.

(*i*) research into improved dry farming technology; and
(*ii*) application of such technology to dry farming areas.

Research on dry farming techniques is being conducted at a number of centres as also at the Central Arid Zone Research Institute at Jodhpur. What is needed is the development of an integrated package of technology. For the Fourth Plan, research is proposed to be taken up on the basis of an All-India coordinated project.

Besides research, the Fourth Plan also proposes taking up specific developmental programmes for application of packages of

technology in the dry farming areas. For this purpose, a Centrally sponsored scheme was launched during 1970-71. Under the scheme nine training-cum-demonstration projects were started during 1970-71 in the states of Andra-Pradesh, Gujarat, Haryana, Madhya-Pradesh, Maharashtra, Mysore, Rajasthan, Tamil-Nadu and U.P.

## TECHNOLOGY

**On the basis of available research findings, the main constituents** of the new technology for dry farming will be :—

(*i*) Soil Management;
(*ii*) Harvesting of water;
(*iii*) New crop varieties; and
(*iv*) New agronomic practices.

Soil management will include measures relating to soil structure, soil fertility and correction of alkalinity of the soil. As regards harvesting of water, the Fourth Plan observes that most of the rainfall in dry areas is received from the South West monsoon and because of the poor soil structure and the undulating topography, much of the water is lost. Hence, steps are necessary for the popularisation of modern water-harvesting procedures including the use of aluminium foil and polythelene film. An important aspect will relate to the introduction of new crop varieties. The development of quick maturing and photo-insensitive varieties has opened up new possibilities. Short duration varieties of castor, *arhar* and *jowar* have been developed. It will be necessary to extend the adoption of these varieties so that double cropping may be practised over larger areas. Among the new agronomic practices would be included the application of nutrients through foliar feeding.

For undertaking the application of new technology, 24 pilot projects are proposed to be organised under the Centrally sponsored scheme included in the Fourth Plan. Each project will be linked up with one of the main or sub-centre for research in dry farming. It was proposed that during the first year, about 800 hectares of compact area would be covered by each project. In the second year, depending upon the success in the initial year, the area was

to be increased to 1,600 hectares, and in the last two years, by about 3,200 hectares. A beginning was made in 1970-71 by starting 9 pilot projects, each of which will ultimately cover about 8,000 heatares of area, to serve as demonstration-cum-training centre. The new technology of development of dry areas would require much more detailed and integrated planning and coordinated action than is the case with irrigated areas. Intensive training programmes for extension personnel will have to precede the introduction of the new technology. For imparting training, it is proposed to utilise the services of agricultural universities and research institutions in all dry areas.

In addition to the special scheme for development of dry farming, included in the Centrally sponsored sector, other plan outlays will also be available for helping to improve the economy of dry land farming. A sizable outlay has been provided in the State Plans for promoting soil conservation measures. It is expected that the bulk of this outlay will be utilised by the State Govts in dry areas. The same will also apply to some of the provisions in the State Plans earmarked for development of animal husbandry and dairying. Again, in the Centrally sponsored sector, funds have been provided for development of commercial crops such as oilseeds and cotton. Since these crops are grown in areas with less than 75 cms. of rainfall, it is contemplated that more than 2/3rd of the outlay under this programme will also be used in the areas characterised by dry farming. It is estimated that the total financial support to the development of dry land farming under various plan schemes will be of the order of Rs. 150 crores.

Apart from the outlays included in the Plan, the Central Govt. annually provides about Rs. 25 crores from the budget as grants to famine affected areas. Over the Fourth Plan period, nearly Rs. 100 crores are likely to be available from this source. Bulk of this amount can be so deployed in the areas chronically affected by droughts as to generate considerable employment in the rural sector, largely related to a pre-planned programme of rural works. The individual schemes of rural works, thus drawn up, should be integrated on the one hand with the general programmes of agricultural development in the area concerned, and on the other, with specific

programmes of development for sub-marginal farmers and agricultural labour,

Repeated famines and prevalence of scarcity conditions in desert areas of the country have brought to the fore the need for developing such areas on a permanent basis. A Central sector scheme of desert development has been formulated under which pilot projects involving schemes of soil conservation, afforestation, minor irrigation and agricultural development are planned to be taken up in Gujarat, Haryana and Rajasthan. For this purpose, a provision of Rs. 2 crores has been made in the Fourth Plan.

Some of the recent developments in varietal improvement are of particular significance to dry farming. (See list of recommended varieties in Appendix VI) The consistency of yield performance of the sorghum Hybrid CSH 1, CSH 2, HB 1 and HB 3 have belied the general belief that the hybrids are for favourable environmental conditions only. CSH 1 has become very popular under extreme moisture stress in the Bellary district of Mysore state as a result of organised extension effort and has attracted the farmers' attention. Similarly, the *bajra* hybrids HB 1 and HB 3, the new early castor variety "Aruna", short duration varieties of *arhar* and *mung*, several varieties of wheat, cotton, etc. could provide the base around which a new package of dry farming practices could be built up to elevate and stabilise the production levels of most crops. Earliness coupled with hybridity, as in the case of maize, Sorghum and *bajra* hybrids, seem to confer an advantage with respect to fitness under environmental stress. Taking into account the mean evapotranspiration during a given season and based on the fact that no moisture is needed by the plant, once it enters the maturation phase, the duration of suitable varieties could be computed for purposes of breeding varieties of suitable maturity, and this in itself would provide an insurance and minimise the risk factor.

The ability of the genotypes to adapt to random and cyclic climatic fluctuations is inherited. Besides agronomic limitations, the factors contributing to adaptive flexibility include basic efficiency of photosynthesis under different light, temperature and moisture regimes, the distribution of assimilates between seed and stalk and

the developmental mechanisms for drought resistence, all of which can be genetically manipulated. With an uncertain monsoon, the sowings are frequently premature or delayed and in either case face specific problems. While breeding varieties for such conditions, inbuilt flexibility through various buffering mechanisms and resistance to prevalent pests and diseases can result in stability of production.

Dry farming has always been treated as subsistence farming. Intensive cultivation approach has been conspicuously absent. No convincing data on response to fertilizers is available and fertilizer application is not encouraged; low seed rates are consciously popularised and plant protection is considered a luxury. A new agronomy has, therefore, to play an active role if the yield levels of these regions are to be elevated.

The available know-how on the various means of soil and water management should be put to best use at the field level through provision and popularisation of the necessary equipment needed. The moisture utilisation efficiency (MNE) under rainfed farming has always been low and never fully utilised. Problems of germination and seedling mortality further aggravate the situation and can be ameliorated through the use of good treated seed, suitable sowing equipment and plant protection measures, where necessary.

There has been a general feeling that fertilisation of dry land crops is un-economic. The poor response of the earlier varieties, lack of equipment to place the fertilizer in relation to seed and want of moisture in top soil when late rains fail for *rabi* crops, are some of the factors responsible for this little enthusiasm. The new varieties have all demonstrated response to fertilizer application. The grain yields of hybrid *jowar* and hybrid *bajra* were demonstrated to be 3-4 times more per kg. of nitrogen in comparison with Locals. Most of the high-yielding varieties presently available, are fortunately of short-duration, non-lodging, fertilizer responsive and photo-insensitive.

Broadcast application of fertilizer is frequently ineffective and is not available to the plant unless moved into the root zone by rain or irrigation water. Placement of fertilizer in relation to seed,

increases the response many-fold. Foliar feeding could also be useful in many instances.

During the *rabi* season, if the late rains fail, application of even a basal dose of fertilizers gets frequently ruled out. If sowing dates are advanced with a possible rainy period ahead, this would facilitate application of a heavy dose of basal application of fertilizers. Some more rain could be anticipated during early growth period and there would also be a possibility of top dressing. Studies in the Rayalaseema region of Andhrs Pradesh revealed that advancing planting dates of *rabi jowar* and *rabi* cotton resulted in substantially increased yields, but the available varieties were most susceptible to shoot fly or Jassids during this period. This limiting factor is no longer insurmountable since powerful chemicals can control shoot fly of Sorghum. One way to stabilize yield levels of scarce rainfall areas is to adjust planting dates in such a way that at least some rains could be received during crop growth. This, coupled with plant protection and the feasibility of effective fertilizer application could raise yield levels.

In planning to stabilise yield levels ef rainfed crops, it is necessary to increase the intensity of cropping in areas with good assured rainfall through practice of relay and double cropping patterns and to develop alternate cropping systems that could stand the stresses of an ill distributed monsoon in areas of scanty rainfall.

The tank-fed areas and areas where traditionally long-duration varieties of 5-6 month duration are cultivated, can be considered for increasing the intensity of cropping Under the tank-fed areas, where rice plantings are possible only in September, an early upland crop of *mung*, hybrid *bajra* or hybrid *jowar* are feasible. Alternatively, rice could be planted as a drill sown crop, irrigated subsequently, and a second crop is feasible after harvest of rice. In long duration *kharif* area, two crops in a season, hybrid *bajra* and hybrid *jowar*, to be followed by gram or linseed or any other crop, is feasible. In the wheat belt, a *kharif* crop can be taken under rainfed conditions. Similarly, in the single-cropped *rabi* areas where plantings begin in September-October, an early *kharif* pulse crop like *mung* is possible. The Setaria-cotton relay cropping is a good example of a relay systen under rainfed farming. Several alternative and specific

systems could be considered for each of the regions. In areas with consistently low rainfall, efforts should be made to raise a good single crop with reasonable yield levels. Forage crops and perennials could find a place in appropriate areas.

While in all regions weather is subject to fluctuation, perhaps in no other habitat is an organism subjected to such rigorous and aberrant climatic conditions as in the arid regions. These extreme conditions make the management of arid regions and the research needed for the sound use of them, a unique and challenging problem. The experience gained in countries like Australia, Israel and the United States makes it abundantly clear that science can help us to mitigate and even avoid the effects of aridity and drought. "Making the desert bloom" is now accepted as a realistic aim. Control of water from the time it falls on the earth untill it reaches the root zone of the crop, can now be attempted in a scientific manner. Various steps can be devised to forge new patterns of soil-plant-water-man relationships, so as to enhance the income potential of farms in dry areas. The rapid progress now taking place in weather forecasting would open up altogether new possibilities in the modification of the weather. New cropping patterns designed to enable the plants to escape drought can be evolved by the combined use of weather models and genetic engineering techniques. Research in these fields in our country is not only important for increasing production in the drought areas but is also vital for the economic upliftment of the people living in such areas and for banishing unemployment and underemployment.

Integrated application of available knowledge is the need of the hour. The variety together with soil and water conservation and management measures, fertilizer and insect control schedules together with the necessary equipment for effective and timely operations, adjustment in planting times, alternate crops and cropping systems, could all provide the necessary package to stabilize the yield levels of dry land farms around 2000 kg. of grain/ha as against the existing 200—500 kg/ha for most of the crops.

# 10

# Small Farmers

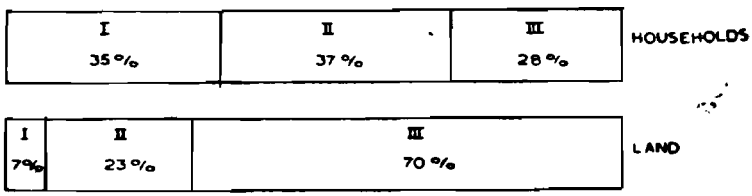
The definition of the term 'Small Farmer' poses several problems. There is no single yardstick that can be applied to establish the identity of the small farmer. The size of the holding alone cannot be a decisive consideration in this regard. There are several other equally important factors viz. the level of technology, availability of water and fertility of soil.

## MAGNITUDE OF THE PROBLEM

Size of the farm is an important consideration for establishing the identity of the small farmer. According to the analysis made by the All-India Rural Credit Review Committee of the Reserve Bank of India (1969),the farmers have been classified into the following three categories on the basis of the size of their land holdings reported in the 1961 census report :

| | *Size of holding (acres)* | *proportion of cultivator households* (%) | *proportion of cultivable land* (%) |
|---|---|---|---|
| I. | Less than 2.5 acres. | 35 | 7 |
| II. | 2.5 acres to 7.5 acres. | 37 | 23 |
| III. | 7.5 acres and above. | 28 | 70 |
| | Total | 100 | 100 |

It will be seen from the above table that the farmer households with holdings of 7·5 acres and above formed 28 percent of the total households and accounted for 70 percent of the cultivable land. On the other hand, the farmer households with holdings of less than 2.5 acres formed 35 percent of the households, but their share in the cultivable land was only 7 percent. In other words, about 1/4th of the households own some 3/4th of the total land and about 1/3rd of the households own only about 1/14th of the total land. The graph below indicates the anomaly in the distribution of land between the three categories of cultivator households.




Of the category I households, about 11 percent had holdings of even less than 1 acre per household. The proportion of holders of category I was largest in Kerala at 80.5 percent, followed by Bihar Tamil-Nadu and West Bengal where nearly one-half of the households belonged to this category. Other states in which the proportion was significant were Jammu & Kashmir, U.P., Orissa, Andhra-Pradesh and Assam. Nearly 2/3rd of the small farm holdings in the country were to be found in the five states of Andhra-Pradesh, Tamil-Nadu, Kerala, Bihar and West-Bengal.

The All-India Rural Debt and Investment Survey throws some light on the financial inputs and transactions of small farmers. The Survey classified the farmers into 3 groups, namely, those with assets of less than Rs. 2,500, those with assets of Rs. 2,500 to Rs. 20,000 and those with assets above Rs. 20,000. The principal findings of this Survey are :-

(*i*) there was not much difference between one asset group and another in regard to indebtedness per cultivated acre or proportion of indebted households;

(*ii*) the proportion of households reporting indebtedness to cooperatives was only 5.1 per cent for the lowest group, but 14.7 per cent for the middle group and 22.6 per cent for

the highest group. Similarly, the proportion of the amount outstanding to cooperatives, to total indebtedness was only 4·2 percent for the lowest group while it was 14 3 percent for the highest group,

(*iii*) the receipts from sale of crops, fodder etc. amounted to only Rs. 69 per household for the lowest group, but it was as much as Rs. 1,796 for the highest group; and

(*iv*) the receipts of the small cultivator from sources other than the crop, were largely by way of wages, accounting for about 83 per cent of the total earnings; whereas it was 31·4 per cent for the highest group. The highest group could earn 19·1 percent of their total receipts from industries and 24·8 percent from trade. The data on capital expenditure in farm business revealed the uneconomic position of small farmers. The proportion of households reporting such expenditure was as large as 85 percent among the highest group, whereas it was only 39·6 percent for the lowest group. Again, the average amount per reporting household was Rs. 716 for the highest group as compared to Rs. 84 for the lowest group.

## CHARACTERISTICS OF SMALL FARMERS

Recently, a number of studies have been made by agricultural economists and others in response to the requests of the Planning Commission. The individual studies show that while the handicaps of the small farmers differ from area to area, the major disadvantages are : (*i*) fragmentation of holdings, (*ii*) insecurity of tenure, (*iii*) inadequate and untimely supply of inputs including water ; and (*iv*) lack of credit facilities and unsatisfactory arrangements for marketing and storage.

The studies also show that with support from irrigation, the new technological development makes it perfectly possible for even a small farm of, say, 3 to 5 acres, to be converted into a viable unit. The data in regard to small holdings show that the total area involved, even if small in relation to the large number of small farmers, is both sizable and significant from the point of view of agricultural production. The participation of small farmers in agricultural programmes based on the new technology is essential also for the far reaching socio-economic implications of leaving this large section of the cultivating population out of the New Agricultural Strategy. Moreover, there are good reasons to believe that the productivity of small farmers is not inferior to that of large

farmers operating under similar conditions. There is ample evidence to prove that the small farmers are not less progressive than the large farmers.

It is extremely important to consider the situation of the small farmer, not in broad and generalised terms, but with specific reference to particular geographical area and socio-conomic environments. The areas differ widely from one another in point of soil, climate and other conditions. The environments vary greatly in many ways, not the least in the degree of development of the infrastructure — credit, marketing, communications and so on, ranging from "highly advanced" in some states to "hardly existent" in other parts of the country.

The general problems of agronomy of the small farmer are not different from those of the big farmer. In an irrigated or assured-rainfall area, a small farmer can and does take to the latest technology of high-yielding varieties as quickly as his counterparts. In a dry area, generally, the small as well as big farmers suffer for the same reasons because they do not know any method by which they can increase their yields.

The problem of fragmentation of holdings puts the bigger farmer to the same disadvantages as the small farmer. In these cases, till consolidation is attempted, there is difficulty in investing in a well or other sources of irrigation, or in any costly equipment.

## SUPPORTING MEASURES

Many of the difficulties of the small farmers can be attributed to the tenancy situation of the area. The implementation of Land reforms has been so uneven in many parts of the country that a tenant is not sure of his rights. The landlord's share is fixed by law in many cases, but in, actual practise, it is generally found to be much higher than what is prescribed under the law. In this situation, the tenant loses much of the incentive needed for adopting improved technology and making investment in the land. The problem of oral tenants is still worse than this. In many cases, an oral tenant is not allowed to cultivate the the same piece of land continuously, for fear of the likelihood of his claiming proprietory-

ship rights over the land. The basic problem of land reforms has therefore, to be tackled vigorously and sincerely. Land records have to be brought up-to-date, showing clearly the rights of different parties on the land. Consolidation of holdings has also to be attempted simultaneously. If these are done, then the basic frame-work will be available for dealing with the problems of this neglected sector in agriculture.

Experience has shown that a small farmer is as good as any other in assimilating and adopting new technology. In many cases, he is better epuipped than this counterparts because he is able to devote intensive attention to his small holding, which may not be possible for others to do. The problem of extension of new ideas and technology is not, therefore, different in the case of small farmers. The question is only of numbers. Small farmers are very large in number. Extension staff needed for dealing with these farmers has, therefore, to be correspondingly large.

In order to change the economy of the small farmer, irrigation has to be given the top priority in areas where it is feasible. Where underground water is available, credit and other facilities must be given, by preference, to the small farmer, to dig a well, install a pumpset or tube-well, as the case may be. Where the area is fit only for deep tubewells or lift irrigation projects from rivers, the State Govt. Should take necessary initiative and make the necessary investment for the benefit of the small farmer. Where an individual small farmer cannot afford to dig a well or install a private tubewell, efforts should be made to give this facility on a group basis. A group of small farmers may jointly own and operate these irrigation units. There are many cases of this type of work on group basis in many areas where water is available from underground or surface source. The availability of water itself would transform the economy of the small farmer. Whatever credit is necessary for this purpose on individual or group basis should be forth-coming from the banking sector.

Land levelling and bunding will be equally important in dry areas for a small farmer. The cost involved is generally high and the returns are not at all as impressive, as in the case of irrigation.

Maintenance of these bunds also presents a problem, precisely because the increase in economic returns is not obvious to the beneficiary. There is equal need for doing complementary work in lands belonging to the Govt. or the village community. Coordinated action on water-shed basis is, therefore, necessary. Only the State Govts. can undertake this work. It will be difficult for the small cultivator to make the required investment in this programme without substantial subsidy from the State Govts. Inadequacy of Plan funds is likely to stand in the way of this programme.

The regular supply of agricultural inputs is an important factor. In a scarcity situation, the small farmer has to face a lot of hardships. The distribution network for many of the inputs like fertiliser is not sufficiently extensive, nor is the salesmanship dynamic enough to reach small farmers. Neglect of this sector by inadequate sales effort of the input manufacturers is a short-sighted policy. The retail depots for distribution of inputs should be available readily and in time to every cultivator in the village, irrespective of his size of the holding.

Tractors and power tillers are beyond the reach of the small farmer. He cannot individually afford to purchase them. A custom service unit will be of great benefit to small farmers. Actively encouraging the development of custom service units, therefore, will help to meet this problem of small farmers. There is shortage of labour at peak seasons such as transplantation, harvesting etc. and mechanisation is necessary even in the case of relatively small farmers, if intensive cultivation of more than one crop is to be attempted. Custom service units of this nature should be given encouragement by the banks by way of credit and by the Govt. through a priority allotment of equipments This will also help to mitigate the problem of educated unemployed, particularly those who are technically qualified to run these units.

Small farmers, in general, are not in a position to earn enough for their living by depending on agricultural crop operations alone. Subsidiary occupations are essential in their case to supplement their incomes. Dairy, poultry, pisciculture, piggery, rural transport, etc.

are some of the occupations which have to be developed to help the small farmer. Here again, the problem is one of marketing. Unless there is adequate arrangement for purchasing the produce of the farmers by giving them a fair price, there will be considerable disappointment. Bank credit also will not flow where adequate marketing and processing arrangements do not exist.

## PLAN OF ACTION

One of the two main objectives of the Fourth plan is to extend the benefits of development to the small farmers and the underprivileged sections of the rural population. "Small Holders" have been roughly defined in the Fourth Plan as those whose holdings are 2 hectares or less. The agricultural labourers have been defined as those who depend on agricultural wages for more than half of their income. According to the Fourth Plan, the small holders represent 52% of the total rural housholds and account for 19 percent of the cropped area. From the production point of view, measures for the benefit of the small farmers may not bring about substantial increases because of the rather small proportion of the land covered by them. Yet they are extremely important from the point of view of social justice. In the words of the Forth Plan :

> "———the new agricultural technology tends to add a further dimension of disparity between those who have the resources to make use of it and those who have not. There is thus the danger of emergence of a sharp polarisation between the more privileged and less privileged classes in the rural sector, the privilege in this instance, relating to the resources and tools of development.

The Fourth Plan has proposed a number of measures in regard to the small farmers, both general and specific. The general measures, which extend to the country as a whole, are complementary in character and pertain to a number of spheres including minor irrigation, agricultural credit and animal husbandry. A large amount of public investment is proposed for community works such as tank and tubewells. Such minor irrigation works will be constructed by the State Govt., Panchayat Raj Institution or other appropriate authorities. As regards agricultural credit, a number of steps are proposed to be taken during the Fourth Plan period for re-orienting the general

loaning policies and procedures of the cooperative institutions in favour of the small farmer. Also, the Agricultural Refinance Corporation will provide assistance for schemes on an area basis, designed to enable the small farmer to take advantage of programmes relating to agriculture, dairy, poultry and other programmes.

The Second direction of effort towards assisting the existing small but potentially viable farmers will be in the form of specific projects in 46 selected districts. A small Farmers Development Agency is proposed to set up in each of these districts.

The main functions of the small farmers' Development Agency will be to identify the problems of the small farmers in its area, to prepare appropriate programmes, to arrange required help to ensure availability of inputs, to organise services and credit and also to evaluate the progress from time to time. To the maximum extent possible, this wil bo sought to be done through the existing institutions — public, co-operative and private, as also local authorities such as the Zila Parishads. The agency may give assistance to small farmers in respect of other services, such as land levelling, machinery and marketing. Whenever necessary, the Agency will itself undertake certain services for the benefit of small farmers. With a view to stimulating the flow of cooperative credit to such cultivators, it will provide grants to the central cooperative bank, the agricultural credit societies and the cooperative land development bank in the area and help them to build up special funds for covering risk, if any, apprehended in such financing. In addition, the Agency will provide a subsidy to these institutions for strengthening their managerial and supervisory staff for this purpose. It will also draw up model plans for investment and production activities to be undertaken by small farmers operating under different sets of conditions.

## SUB-MARGINAL FARMERS

The typically non-viable small farmers fall basically into the same category as landless labour. Their submarginal holdings do not fully employ the available family labour and hence the potential solution lies elsewhere than merely in crop husbandry. According to the Census in 1961, there were about 31 million agricultural labour in the country. The impact of the new agricultural technology on the

economy of agricultural labour has been varied. In certain areas, with greater intensity of cropping, agricultural income had tended to by-pass the sub-marginal cultivator and agricultural labourer. In several other areas, however, these groups have also suffered by the growing disinclination on the part of the bigger farmers to lease out their lands, or on account of mechanisation of agriculture.

The Fourth Plan, proposes to deal with the problem of sub-marginal cultivators and agricultural labourers by two sets of measures. The first set of measures lies in the sphere of land reforms. The second set of measures has for its aim the generation of employment oriented activities.

For the large class of sub-marginal farmers, agricultural labour and landless labour, the remedy lies in the provision of supplementary occupations and other employment opportunities. Both occupations and employment will have to be integrated into local planning. This is sought to be done by the government through a series of 40 projects, located in different districts all over the country. By July 1971, 43 such projects had been set up. These projects would, as far as possible, be market-based (*i.e.* centred round towns or other areas of demand) so that there is scope for development of employment oriented activities, such as poultry and dairy farming. Stress is proposed to be laid on using the funds for development of various marketing and processing facilities with a view to giving organised support, preferably through cooperatives, to the activities of sub-marginal cultivators and agricultural labourers. Both in the content and coverage, these projects will be distinct from other projects designed for the potentially viable farmers although geographically, the areas of operation of two sets of projects may coincide in appropriate contexts. Where this happens, it may be possible to use the small Farmers' Development Agency as the instrument for executing both the schemes. In other cases, a separate but analogous agency would have to be set up for the purpose.

There is a provision of a financial support of Rs. 115 crores in the Fourth Plan for the dovelopment of small farmers and agricultural labour. These financing provisions are expected to help in attracting to these projects a considerable volume of credit from various institutional sources. On the basis of the small farmers'

projects approved so far, it is estimated that the total flow of short-term credit under 46 small farmers development projects is likely to be of the order of Rs. 90 crores per annum, when all these projects are fully in operation. The long and medium term credit likely to be made available to the project areas during the plan period, may be placed at approximately Rs. 117 crores. As regards 45 projects for the development of sub marginal cultivators and agricultural labour, the institutional credit support will not be as substantial. However, an annual short-term credit of about Rs. 10 crores is likely to be made available in the project areas. The corresponding estimate for medium and long-term credit is Rs. 30 crores. Thus the total institutional support likely to be forthcoming in the long run for the two sets of projects is of the order of Rs. 300 crores, comprising short-term credit of Rs. 100 crores per annum and medium and long-term credit of Rs. 200 crores for the total duration of the projects.

Comparing the Governmental efforts in the form of financial allocations and the magnitude of the task, however, it appears that it will hardly be possible to touch even the fringes of the problem. With all that has been proposed to be done for the small farmers, a very huge proportion of the population will remain without having received any benefits and the problem of the widening gulf between the rich and the poor may continue to pose a great danger for the balanced and orderly growth of Indian economy.

## APPENDIX I

### Proposals of the Ford Foundation Team (1959).

1. *The Third Plan Target* :

A third plan target of 110 million tons of foodgrains by 1965-66 is reasonable in view of India's rapidly rising population. Eighty million more people, or a total population of about 480 millions, are expected by the end of the Third Plan. A 110 million ton target is needed to provide food enough for the added millions, and to provide for some dietary improvement and a safety margin for poor crop years and emergency condition.

2. *The Impending Gap* :

India is making steady progress in increasing food production, but the rate of increase must be tripled to meet the Third Plan target. If India's food production increases no faster than present rates, the gap between supplies and target will be 28 million tons by 1965-66. This will be about 25 per cent shortfall in terms of need. No conceivable programme of imports or rationing can meet a crisis of this magnitude.

3. *The Need for Emergency Action* :

A Third Plan target of 110 million tons of domestic production can be achieved. The best in Indian agriculture is comparable to the best in other countries. The task is to develop ways of raising the low average to the highest levels which some Indian cultivators have achieved.

A 110 million tons target, however, can be realised only if an all out emergency food production programme is undertaken. Food productions must be given the highest priority. It must have the sponsorship of topmost leaders who can and will mobilize the nation for action to meet the impending crisis.

4. *The Need for stabilization of Farm Prices* :

Unless the cultivator is assured of a floor price for his foodgrains, he will be unwilling to invest in fertilizer, better implements, improved seed and other expenses necessary to increase production.

Recommended incentives for increased production are :

*a*) A guaranteed minimum price announced in advance of the planting season.

*b*) A market within bullock-cart distance that will pay the guaranteed price when the cultivator has to sell.

*c*) Suitable local storage. Immediate consideration should be given to using funds available from grain imports under PL 480 and other special programmes to construct needed godowns in village areas.

5. *A Public Works Programme for Increasing Food Production and Village Employment*

The unemployed and underemployed in the villages represent a waste of resources that should be used to produce more food. Moreover, about 45 million of the 80 million increase in population will be rural people. The Team recommends a public works programme for projects requiring primarily hand labour, such as contour-bunding, land levelling, surface drainage, irrigation wells and tanks. Such works will contribute directly to increasing food production, provide income for needy people, and will not be inflationary.

6. *Priorities for Chemical Fertilizers*

Fuller use of manures, composts and green manures is commended. But at the very best, these can be substitute for only a small fraction of the chemical fertilizers needed to meet third plan food targets. Benefits from irrigation, bunding, improved seeds, and other facilities will be realized only with more abundant chemical fertilizers.

The targets for fertilizers to be made available for the end of the Third Plan, developed in the Ministry of Food and Agriculture, are soundly based but are conservative in relation to need. These amount to 1,500,000 tons of nitrogen, 750,000 tons of phosphoric acid, and 200,000 tons of potash. Even though conservative, they mean a 9-fold increase in the use of nitrogen and considerably larger increases of the others, the use of which has just started.

Hence the team recommends that procurement of fertilizers and means of producing high-analysis fertilizers be given a top priority, including foreign exchange as necessary.

7. *Intensified Irrigation and Drainage Programmes*

India is using only a small portion of its potential water supply, which is one of the largest in the world. India now gets only one fifth to one-fourth ton increase in crop yields on irrigated lands as compared to non-irrigated lands. Moreover only about 12 per cent of irrigated acreage grows more

than one irrigated crop per year. India cannot afford this waste of resources. Better water management is needed.

The team believes that India can make greater and more immediate gains in food production by intensifying expenditure of time and effort on water management than by constructing large-scale irrigation projects which take years to develop. The team recommends that the Third Plan allocate substantial funds for technical assistance to aid cultivators in making better use of available water. Provision must also be made for a more comprehensive approach with coordination of all relevant departments. The team also recommends that more emphasis be placed on irrigation projects which will yield rapid returns in food production, such as tube-wells and shallow masonry wells.

Millions of acres could be reclaimed and made more productive by drainage improvement. The Team recommends that drainage improvement be given a high priority and believes that a unified agency is necessary in each state for coordination and improvement of drainage.

8. *Selection of certain crops and certain areas for more intensive efforts.*

There are tremendous physical potentialities for increasing production per acre if they can be achieved. There are no inherent soil, climatic or other physical reasons for the present low yields. But there are no blanket proposals that can be generally applied to reach the Third Plan target. The Team recommends that those selected crops and those selected areas in each state should be chosen which have the greatest increase potentialities

Efforts to stimulate food production should be directed more heavily to rice and wheat, which now make up more than half of total food-grains With hybrid maize, india can, in 5 to 7 years, make more progress in increasing yields than the USA made in 20 years.

More efforts should be concentrated on the most promising areas for wheat and rice production, *i e*, those which have had the most rapid rate of increase in the recent past, and which have also the highest potential for rapid large increases in the years immediately ahead. For rice, there are 25 important growing districts : for wheat, there are selected districts in the Punjab U.P., M.P. and Bihar.

These areas will, the Team believes, increase India's food production more rapidly than others, if given allocation of

fertilizers in combination with other improved practices such as plant protection measures, improved seeds, and water for irrigation. Attention to other areas should not be reduced. But, in the national interest, the Team believes that increased efforts should be immediately directed to the most responsive areas.

9. *Security of Land Tenure and Land Consolidation* :

Assurance of stability of tenure can contribute substantially to food production. The team's recommendation is that land ceilings and other reforms should be settled as quickly as possible, and stay settled for the Third Plan. Firm plans should be developed immediately to schedule the completion of consolidation of fragmented holdings, village by village, as soon as possible. Improved coordination must be provided. In some Indian villages, consolidation has been carried out in ways to increase production greatly ; in others it has not, because of inadequate coordination with those responsible for planning water control structures and boundaries of holdings.

10. *Immediate Large-Scale Credit Through Cooperatives*:

The present marketing, supply and credit services are major deterrents to increasing food production. Eighty-five per cent of credit is now supplied by money lenders and other individuals. Most marketed grains are sold to local traders at harvest time at depressed prices. Strong co-operatives can break these bonds.

To help cooperatives do so effectively, the Team's major recommendations are that (1) Government must be prepared to provide loans and to assist in developing capable management ; and (2) standards of credit worthiness must be redefined to encourage production loans on the basis of expected crop yields and repayment ability, instead of land security.

11. *Progressive Reduction of Cattle Numbers* :

The excessive animal population competes with people for the products of the land. The Team recognizes the limitations imposed by beliefs concerning cattle slaughter. Other way of dealing with the problem are possible.

The Team recommends that legislation be considered providing for : (1) a tax policy which makes maintenance of useless cattle a burden on their owners (tax receipts could go to villages for improvements ; (2) confinement of all bulls and mandatory castration of all bulls not kept for breeding ; (3) measures to control open grazing ; (4) establishment of dessicasting plants to process fallen animals, with incentive payments to owners who bring in fallen cattle.

12. *The urgency of a High-Level Coordinating Food Production Authority* :

Far-reaching centralized authority with a clear line of command and execution alone can meet the challenge of growing more food. The Team believes that such authority is essential to allocate resources on a priority basis-such as personnel, fertilizers, steel (for sprayers, godowns, fertilizer plants, etc.) ; to coordinate irrigation drainage and soil management programmes ; and to enforce policy decisions giving priority to food production. The administrative structure, moreover, must be simplified and clear lines of authority and responsibility established at all levels of Government, so that policy decisions are carried out to the village level.

13. *The Role of Community Development and the Technical-Ministries* :

Community Development and all technical agencies must be geared to mobilization and strengthening of village leaders and organizations, and effective channelling to village people of all information and help necessary to increase food output.

All ministers concerned with any aspect of programme relevant to food production must give top priority to food production now and for the Third Plan.

## APPENDIX II*

## PACKAGE OF PRACTICES

### A. HIGH-YIELDING I.R. 8 PADDY

I. R. 8 gives very high yields. But grow it only where you have assured water supply.

I. R. 8 produces ears bigger than those of Taichung Native I. Its grains are also bigger and bolder. The rice is fairly good. This variety is less susceptible to bacterial blight disease. It, however, needs protection from bacterial streak disease and gall fly attacks to which it is susceptible. It matures in 130 to 150 days, depending on the season.

### TREAT THE SEED

I.R. 8 seed from the National Seeds Corporation is normally treated against bacterial blight. If the seed you have obtained is not treated, better treat it before sowing.

Mix 0.5 gram of streptocycline and 10 grams of a one per cent wettable organo-mercurial compound in one kerosenetinful (18 litres or 4 gallons) of water a day before sowing. Two such tinfuls will suffice for treating 25 to 30 kilos of seed that you need to raise a hectare of the crop. Take out all the floating seed. Keep the rest soaked for 8 to 12 hours. Remove the seeds and dry in the shade before sowing.

Prepare well-drained nursery beds, each 1½ metres wide and of any convenient length. You can also sow direct in the field but you have to be careful so that you use a correct seed-rate. Just before the final preparation of the nursery beds, apply one basket (about 20 kilos) of well-rotted powdered compost on every 10 square metres of the nursery area. Also add half a kilo each of superphosphate and ammonium sulphate.

Sow 300 to 350 grams of seed in lines five centimetres apart on every ten square metres of seed-bed.

You need about 25 to 30 kilos of seed to raise seedlings for a hectare.

### PROTECT THE SEEDLINGS IN THE NURSERY

Protect the tender seedlings from pests and diseases by spraying twice with a protective mixture.

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*– Based on H.V.P. Campaign Leaflets.

To prepare the mixture, mix 15 cc. (3 teaspoonfuls) of 50 per cent parathion or 36 cc. (7 teaspoonfuls) of 20 per cent endrin (emulsifiable concentrate—E. C.) or 72 grams each of 50 per cent DDT and 50 per cent BHC wettable powder in one kerosenetinful of water.

Give the first spraying 15 days after sowing, with 20 kerosenetinfuls of mixture per hectare and the second one a day or two before transplanting.

## PREPARE THE FIELD AND MANURE IT

Select a well-drained field. Puddle it well in advance. Apply 60 quintals of farmyard manure or compost per hectare.

I. R. 8 needs 100 kilos of nitrogen, 65 kilos of phosphoric acid and 45 kilos of potash per hectare. Of course, this varies with the fertility of your soil. So get your soil tested and give fertilizers accordingly.

Just before the final puddling, apply all the phosphatic and potassic fertilizers and three-fourths of the nitrogenous fertilizer. Level the field with a plank.

## TRANSPLANT IN TIME

Transplant the seedlings when they are about 10 to 15 centimetres (4 to 6 inches) tall and have four or five leaves. In kharif, this will be after 20 to 25 days of sowing, and in rabi after 30 to 35 days. Do not delay transplanting. Never transplant the kharif crop later than July; otherwise gall flies will destroy the seedlings.

Plant two seedlings erect per hill not more than 2·5 centimeters deep when the puddle settles down. Give a spacing of 25 by 10 centimetres to the kharif crop of I. R. 8 and by 10 centimetres to the rabi one.

About a fortnight after transplanting, work a push-hoe (Japanese weeder) in between the crop rows. Thereafter, hand-weed whenever necessary.

However, in a closely planted crop, hand-weed regularly, starting from the first fortnight after transplanting.

## TOP-DRESS THE PLANTS

When the plants are at the boot-leaf stage, apply the remaining quantity of nitrogen in between the rows.

## PROTECT THE CROP

Spray the crop four times—15, 35, 50 and 70 days (at the short-blade stage) after transplanting.

For the first and second sprayings, mix 3 teaspoonfuls (15 cc) of 50 per cent parathion or 7 teaspoonfuls (36 cc) of 20 per cent endrin E.C. or 90 grams each of 50 per cent DDT and 50 per cent BHC (wettable powder) in one kerosenetinful of water, Use 25 kerosenetinfuls of the mixture for spraying a hectare.

See that the base of the plants is thoroughly sprayed. This will keep away gall flies.

For the third spraying, use 30 kerosenetinfuls of the mixture as in the first spray per hectare. If bacterial streak appears, add 0·2 gram of streptocyclinc to the spray mixture.

For the fourth spraying, prepare the spray mixture as for the first spray. If the bacterial streak attack persists, add 0.2 gram of streptocycline also to the mixture. Use 40 kerosenetinfuls of the mixture per hectare.

## KILL RATS

Kill rats by poison baiting at the earing stage of the crop. To prepare the bait, mix 1·4 kilos of zinc phosphide with an equal quantity of an edible oil or molasses and 45 kilos of cereal grains. Make small balls. This much of the bait is enough for 40 to 60 hectares.

## CHECK PESTS

In case there is an attack of pests :

- Dust the crop with 10 per cent BHC at 12 kilos per hectare against rice hispa, caseworm and leaf roller.
- Dust 12 kilos of 10 per cent carbaryl against delphacids (fulgorids) and jassids.
- Dust 5 per cent malathion at 20 kilos or 10 per cent BHC at 12 kilos per hectare against gundhi bugs and earhead cutworms.
- The application of lindane granules (2 kilos of the active ingredient per hectare in 5 centimetres of standing water) controls borers effectively. Allow the water after treatment to remain in the field for two or three days. This treatment will cost you about Rs. 130 per hectare.

In places where the pests and disease attacks had been severe, burn all the stubbles after the harvest.

Keep in mind the following points when you use insecticides.

All the pesticides cre poisons. Handle them with care. Read and follow the manufacturer's instructions carefully. Instead of adding streptocycline directly to the mixture, prepare a stock solution first. Mix 7·5 grams of streptocycline in one kerosenetinful of water. Add half a litre of this stock solution to every kerosenetinful of the spray mixture.

When the crop is in flower, do not spray in the morning. Stop spraying endrin 45 days before the crop matures,

Always spray along the wind direction and not against it. If necessary, vary the spraying timings, depending on when the pests appear in your locality.

The quantity of the spray fluid recommended here is meant for large volume high pressure sprayers. If you are using a low volume sprayer, you need 40 to 80 litres of the corresponding higher concentration of the spray fluid for every hectare.

## IRRIGATE PROPERLY

Keep about 2 centimetres of standing water in the field after planting.

When the crop has produced the maximum number of tillers, drain out the water from the field completely. Let in water again after four or five days.

Keep about 5 centimetres of water from the flowering time till the grains become hard. After this, drain out all water.

Raise the crop in compact blocks as this will enable you to let in and let out water easily.

## HARVEST IN TIME

Harvest the crop as soon as it is fully mature. Otherwise, the grains will shatter.

Consult your Extension Officer or Gramsevak for local recommendation.

## B. HIGH-YIELDING MAIZES

Select a well-drained soil that is free from saline patches.

### PREPARE THE LAND WELL

Plough the land 15 centimetres deep with a mould-board plough. Cultivate the field several times till it is smooth and clean.

Apply in rows 15 kilograms of 5 per cent aldrin of heptachlor dust per hectare (15 pounds per acre) at the time of sowing, if white ants and white grubs are a problem in your area.

### BUY CERTIFIED SEED

There are several high-yielding maize varieties. Some are hybrids and some are composite varieties. There are seven hybrid maize varieties—Ganga 3, Ganga 101, Ganga Safed 2, Ranjit, Deccan, Hi-starch and Himalaya 123.

Ambar, Vijay, Vikram, Kisan, Jawahar and Sona are the composite varieties.

If you are sowing a hybrid maize, get only new certified seed from a reliable agency every time you sow. In the case of a composit maize variety you need not go in for new seed every time. You can use the seed from your own crop. It would, however, be, necessary to get a fresh supply of seed of any composite variety after every five or six years.

Consult your Agricultural Officer for the high-yielding maize variety that will suit your area best.

Use only 16 kilograms of seed to sow a hectare (6½ kilograms per acre).

Sow in time

In the North Eastern Himalayan Region, start sowing from the second week of March to the middle of April.

In the Western Himalayan Region, sow from the second fortnight of June to the 15th of July.

In the Northern Plains, sow from the first week of June to the middle of July.

In the Peninsular India, sow from June to the middle of July. For rabi, sow from the end of October to the first fortnight of December.

## SOW WITH CARE

Dibble the seed behind a plough. Do not sow deeper than 2½ centimetres. Sow in rows 60 centimetres apart. Give 30 centimetres of space in between the plants. You can use a planter. It will ensure right placement of seed and fertilizer.

## APPLY FERTILIZERS

To get a good crop-yield, apply 95 kilogroms (38 kilograms per acre) of nitrogen, 60 kilograms of phosphoric acid (24 kilograms per acre) and 50 kilograms (20 kilograms per acre) of potash per hectare. If you had your soil tested, apply fertilizers as advised.

Apply one-third of the nitrogen and the whole of the phosphatic and potassic fertilizers at the time of sowing. Place these fertilizers 5 to 7 centimetres below the seed and 7 centimetres away from the seed rows.

Give another one-third of nitrogen a month after sowing along the crop rows and the remainder two months after sowing, that is, at the time when the tassels come out.

If your area receives high rainfall, apply the nitrogen only in two doses — half at sowing and the other half a month later.

Keep the field free of weeds. If you want, you can use weedicides. Use Simazin at 1·5 kilograms per hectare before the weeds come up, and 2, 4-D sodium salt at one kilogram per hectare about 3 or 4 weeks after sowing. If you do not use weedicides, hoe the field two weeks after sowing. Follow it up with weeding.

If you expect heavy rains, earth up the crop after applying the second does of fertilizers. This will prevent fertilizers from being washed away and also help in the drainage of excess water from the field. While earthing up, take care to see that the roots are not disturbed.

## IRRIGATE WHEN NECESSARY

Maize is sensitive to both drought and waterlogging.

Do not allow the crop to wilt at any stage particularly at the flowering and seed development stages. Once the maize plants receive a set-back due to want of water, they do not recover fully. Irrigate the plants before they show any sign of wilting.

Do not allow water to stagnate in the field for more than 6 to 8 hours. Drain the water out.

You can also plant your crop on ridges. This will not only prevent damage due to stagnation of water in the field but also help in saving on irrigation water.

## PREVENT PEST ATTACK

There is always a threat of stem borer, grasshopper and weevil attacking your crop. Spray the crop as follows three times :

Mix 48 cc. (9 teaspoonfuls) of 20 per cent endrin or 20 per cent BHC emulsion or 72 grams (2.5 ounces) each of 50 per cent DDT and BHC wettable powder or 50 grams of 50 per cent carbaryl in 18 litres (one kerosenetinful) of water.

Give the first spray two to three weeks after sowing. Use. 20 kerosenetinfuls or 360 litres (32 gallons per acre) of the spray mixture per hectare.

Spray again with 450 litres or 25 kerosenetinfuls (40 gallons per acre) of the same spray mixture after 10 to 15 days of the first spraying.

Three to four weeks later, repeat the spray with 720 litres or 40 kerosenetinfuls (64 gallons per acre) of the mixture, if the borer attack persists.

N.B. Application of 2 per cent endrin granules to the leaf whorls at 22 kilograms per hectare — once after 15 to 21 days and again after 35 to 42 days of germination and also at the tasselling stage, if the borer attack still persists, has been found to give better results.

## CONTROL PESTS

In case there is a heavy borer attack, spray the crop with 720 litres or 40 kerosenetinfuls of the spray mixturs containing endrin or BHC and DDT at the flowering time. Prepare the mixture in the manner indicated under 'Prevent pest attack'.

If there is an attack from armyworms or red hairy caterpillars, dust 10 per cent BHC at 20 kilograms per hectare (20 pounds per acre) or 2 per cent parathion or 5 per cent malathion at 15 kilograms per hectare (15 pounds per acre).

## KILL RATS

Kill rats by poison baiting with zinc phosphide. Use the baits at the time of flowering.

Mix 1.4 kilograms (3 pounds) of zinc phosphide, 1.4 kilograms (3 pounds) of an edible oil or 1.4 kilograms (3 pounds) of molasses and 45 kilograms (100 pounds) of cereal grains. The bait thus prepared will be sufficient for treating 40 hectares.

Rats are better controlled when all the farmers of an area get together and take up poison-baiting jointly.

## CAUTION

All the pesticides recommended for controlling the pests are poisons. Handle them with care and read the manufacrure's instructions carefully. Stop spraying endrin 45 days before the maturity of the crop.

Always take the advice of your Gramsevak or Agricultural Extension Officer for any information you need.

## APPENDIX III

**The terms of reference of the National Commission on Agriculture.**

1. To examine comprehensively the current progress of agriculture in India and to make recommendations for its improvement and modernisation with a view to promoting the welfare and prosperity of the people;

2. In particular, to investigate and report on the following aspects of agriculture;

*A. Crop Production and Land and Water Development*

(*i*) Economics of land and water utilisation and the patterns, and scope for expansion of crops for balanced and nutritious food, industrial uses and exports with special reference to the need and scope for development of horticulture;

(*ii*) Problems of soil and moisture conservation, particularly those releated to the catchment areas of the major irrigation projects on the one hand and the composite implementation of soil conservation measures and improved agricultural practices on the other ;

(*iii*) Problems of water management and ground water exploitation in relation to other surface irrigation projects, major and minor;

(*iv*) Programmes for land reclamation and development with special consideration of the needs of areas affected by soil salinity;

(*v*) Requirements of the new strategy of scientific agriculture in the shape of requisite supplies of inputs and production requisites with special consideration of sources of supply and problems and in particular :—

(*a*) multiplication, distribution of high-yielding varieties of seed and other improved seeds ;

(*b*) propagation of soil nutrients including chemical fertilizers and other organic manures ;

(*c*) Measures for plant protection keeping in view the risk of pollution, and

(*d*) agricultural credit from Government, cooperative and other institutional agencies ;

(*vi*) The scope and long and short-term potentiality for mechanisation of agriculture in the context of the use of advanced technology involving the use of high yielding varieties and adoption of multiple cropping without having adverse affect on rural employment situation.

B. *Animal Products, Fishery and Forestry*

(*i*) Development of animal husbandry both for providing nutritious diet to the populution, draft power for agricultural operations and income and employment opportunities to the rural population :

(*ii*) Development of poultry, piggery, sheep and goats for increasing income and employment opportunities in the rural areas, besides contribution to balanced diet ;

(*iii*) Measures necessary for disease control in animal population to increase their efficiency ;

(*iv*) Development of fisheries, marine, inland and estuarine for increasing income and employment opportunities for the weaker section of population dependent for their livelihood on this occupation, besides their contribution to balanced diet and export earnings ;

(*v*) Development of forestry, including farm forestry as a factor in agricultural progress and as a source of raw material for industry, exports as well as for sustaining the ecological balance in nature, and for providing employment opportunities to large sections of tribal and other population living in these areas ;

C. *Research, Education and Training*

(*i*) Achievements, deficiencies and potential of the development of agriculture research and steps needed for promotion of agricultural research and its application to field conditions in the context of fast developing technology ; and the need for scientific demonstrations on farmers' fields, for gearing up extension machinery and for the establishment of a two-way channel between farmers and scientists ;

(*ii*) Education and training of personnel, (*a*) at the level of Universities and higher agricultural education, (*b*) middle level training of personnel engaged in occupations ancillary to agriculture, and (*c*) training of government and other personnel connected with agricultural development ;

(*iii*) Role of farmer's training and edocation, and methods of mobilisation of human resources and ensuring people's participation in agricultural development programmes.

*D. Organisation and Supporting Measures*

(*i*) Examination of the structure and organisation of existing agencies and personnel both Government and non-government engaged in the operation of agricultural research and development programmes and improvements and adjustments necessary to suit the changed requirements for the formulation of policies, preparation of programmes and implementation of action in the field ; and the relative role and responsibilities of Central and State Governments ;

(*ii*) Development of transport, marketing and storage and processing industries with particular reference to food processing to support the programmes for growth in agricultural production, including horticulture and animal husbandry.

*E. Employment and Manpower*

(*i*) Employment potential of agricultural sector and the implication of the goal of full employment in agriculture for policies and programmes ;

(*ii*) Scope for pilot projects to demonstrate the types of schemes necessary for creating employment opportunities in the rural areas.

(*iii*) Manpower requirements for agriculture programmes and methods of recruitment and training ;

(*iv*) Problems of small farmers and agricultural labour, viewed in the context of social justice and equality of opportunity and as a factor in securing effective participation of the bulk of the Indian peasantry in stepping up agricultural production ;

*F. Other Aspects*

(*i*) Concept, potential and measures necessary for integrating area development with special reference to dry and rain-fed areas, command areas of irrigation projects and remote, economically backward, hilly and tribal areas ;

(*ii*) Land reforms, consolidation of holdings and the link between land reforms and agricultural production ;

(*iii*) Study of agricultural price problems as a policy of incentives for agricultural production ;

(*iv*) Crop insurance ;

(*v*) Availability of reliable and timely agricultural statistics for formulation and implementation of agricultural policies and programmes.

## APPENDIX IV

**Recommendations of the Jha Committee :**

1. Though foodgrains constitute the most important item of agricultural production in India, there were many other agricultural commodities which were in short supply and whose production may be expected to respond favourably to a positive price policy. In the case of several such commodities, e.g., cotton, jute and sugarcane, Government announced prices every year. In the case of some other commodities, e.g., oilseeds, prices were sought to be influenced through other measures. It is desirable that the price policy of all agricultural commodities should come within the purview of the Agricultural Prices Commission, so that a balanced and integrated price structure could be evolved and the claimes of the competing crops on limited resources could be resolved in the perspective of the over all needs of the economy. ———————————— To start with, the Agricultural Prices Commission should be vested with the responsibility of advising on the price policy for important agricultural commodities like paddy, rice, wheat, jowar, bajra, maize, pulses, sugarcane, oilseeds, cotton and jute and if the question of appropriate price policy in respect of any other agricultural commodity came up for consideration, Government should, in the interests of the integrated price policy, refer the matter to the Agricultural Prices Commission.

2. One of the most important problems facing the national economy is that of augmenting agricultural production in a big way. This could be brought about mainly through the adoption of improved technology and additional investment required for the purpose. To the extent that the price policy can assist this process, it should be its major objective to do so. While adoption of improved technology would entail larger expenditure, it would not necessarily result in higher cost per unit on output. Generally, it would be reasonable to expect that improved practices and technology would reduce rather than increase per unit cost. However, the possibility of an increase in unit cost cannot be ruled out. Besides, there is the factor of risk and uncertainty involved in the adoption of new technology. The incentive, if at all considered necessary, should be given through the cost reducing scheme such as, for example, supply of improved varieties, pesticides, fertilizers, etc., at cheaper rates, or through increase in prices.

3. The aim of the price policy should also be to encourage optimum utilisation of land so that the climatic and soil variations in different regions are exploited to the best advantage of the economy. It is necessary to distinguish between productivity—in input-output terms and profitability, which depends upon the additional factor of curret relative prices. The shift in the cropping pattern due to partial price controls needs to be avoided.

4. In regard to an appropriate relative price structure among different crops, the main consideration should be to avoid the year to year excessive diversions of land and resources from one crop to another, which are not technically and economically warranted, to ensure efficient use of land. For this purpose, it would be necessary to assess the demand and supply conditions of each crop at the beginning of the year and then arrive at the required marginal adjustments in prices so as to achieve, as near a balance as possible, between the expected supply and demand conditions during the following year.

5. In recommending relative prices for different agricultural commodities, conditions in international markets should also be taken into consideration. In assessing their impact on domestic markets, the possibilities in regard to imports and exports of agricultural commodities become relevent.

6. In view of the fact that agriculture accupies a predominant place in the national ecanomy, the level of agricultural prices has a decisive influence on the general level of prices in the country. While prices have an important role in providing incentive to the farmer for adopting new technology, there is a limit beyond which the rise in prices may not be considered desirable from the point of view of the economy as a whole. The Commission should, therefore, keep in view the likely effect of the price policy on the rest of the economy, particularly on the cost of living, level of wages, industrial cost structure, etc. While prices influence the return to the farmer, gross incomes also depend on the volume of production and the net income on the cost of farm operations. Increased efficiency in the use of inputs, such as land, water, fertilizers, etc., will raise incomes without an increase in prices. It is a better economic policy to ensure higher incomes through more efficient Production, i.e. by raising yields and reducing the unit cost, than through higher prices. It is necessary to ensure that higher prices, which may be recommended for agricultural produce, do not merely result in higher prices of agricultural inputs, either because of the inelasticities of domestic production, or the non-availability of foreign exchange for imports. If higher prices get quickly reflected in higher costs, the

incentive effect of the former will disappear, resulting merely in cost inflation.

7. The effectiveness of price policy as an incentive to higher propuction would depend upon several other factors — some general to the whole economy and others more particular to agriculture. To the first category belong the fiscal and monetary policies, which, though obviously beyond the purview of the Commission, will have intimate bearing both in its recommendations and their implementation. Commission should have the latitude to convey its views to Government in regard to such non-price aspects pertaining to Agricuitural policy as have a direct impact on production and hence on agricultural prices.

8. One of the important functions of the Commission should be to see that the benefits of the price policy accrue to the producer on the one hand and to the consumer on the other. For this purpose, the Commission will aim at ensuring that marketing services are made available at reasonable costs. In order to achieve this objective, the Commission would look into the present methods and cost of marketing of agricultural commodites in different regions, suggest measures to reduce costs of marketing and recommend fair margins. Since imported foodgrains constitute an important part of the total availability for foodgrains in the country, the Commission should recommend the issue prices for imported foodgrains also. The Commission should be free to suggest the measures which in its view should be taken to make the price structure recommended by it, effective. In this context, the Commission may examine the bearing of the system of procurement, inter-state movement, issue prices of imported foodgrains, system of fair price shops and rationing, buffer stock operations, etc, on the prices of foodgrains, and suggest possible improvements. The Commission will also have to keep itself in touch with the Food Corporation of India.

9. While making recommendations, the Commission should keep in view financial and fiscal limitations of government so that the recommendations are not found to be impracticable. It would be a good convention if the recommendations of the Commission having financial and fiscal implications are given separately from other recommendations which do not have such implications. Moreover, in a sensitive field like prices, the Commission should continuously watch the effects of its recommendations as implemented, so that, if necessary, it can make appropriate suggestions to Government for mitigating the stresses and strains that might develop. The determination and implementation of prices is an intricate and complicated exercise, and the expert advice of the Commission on a

continuing basis to the Central and State Governments would be highly valuable.

10. For evolving a scientific basis for determining the prices of different agricultural commodities, the Commission would require technical data and results of research studies on a number of items, e.g. prices, costs and margins at different stages of marketing, normal trade patterns, additional costs and benefits from improved techniques, etc. The Commission should review the present arrangement for relevant studies and for the collection of information regarding agricultural prices and other related data and suggest improvements in them. The Commission may make suitable arrangements through research institutions for the collection of additional data and the conduct of relevant studies which may be deemed necessary and useful for discharging its functions effectively.

11. The Commission should keep a close liaison with the work of the Steering Group for Policy in regard to Wages, Incomes and Saving so that the necessary coordination between the agricultural price policy and income policy is achieved. Likewise, the Commission should keep in touch with other bodies set up by Governments in connection with matters having a bearing on prices and production, *e.g.*, the Food Corporation of India."

## Appendix-V

**Literacy Rate of Population per 1000 Persons in Selected Dry Districts**

| | *State/District* | *Literacy Rate* |
|---|---|---|
| 1. | **Andhra Pradesh** | **212** |
| | (i) Anantapur | 206 |
| | *(ii) Mahbubnagar* | *135* |
| | (iii) Nalgonda | 141 |
| 2. | **Gujarat** | **305** |
| | (i) Jamnagar | 206 |
| | (ii) Surendranagar | 245 |
| | (iii) Kutch | 250 |
| | (iv) Bhavnagar | 274 |
| | (v) Amreli | 289 |
| | (vi) Banaskantha | 127 |
| 3. | **Maharashtra** | **298** |
| | (i) Dhulia | 251 |
| | (ii) Sholapur | 251 |
| | (iii) Sangli | 281 |
| | (iv) Aurangabad | 179 |
| | (v) Bhir | 151 |
| 4. | **Mysore** | **254** |
| | (i) Chitaldurg | 251 |
| | (ii) Bellary | 209 |
| | (iii) Bijapur | 244 |
| | (iv) Raichur | 157 |
| | (v) Gulbarga | 147 |
| 5. | **Punjab** | **242** |
| | (i) Gurgaon | 205 |
| | (ii) Hissar | 174 |
| | *(iii) Mohindargarh* | *180* |

| | | |
|---|---|---|
| 6. | **Rajasthan** | **152** |
| | (i) Sawai Madhopur | 127 |
| | (ii) Tonk | 114 |
| | (iii) Pali | 136 |
| | (iv) Jalor | 80 |
| | (v) Barmer | 75 |
| | (vi) Nagaur | 133 |
| | (vii) Jaisalmer | 81 |

**Source** : Levels of Regional Development in India, Census 1961, Registrar General of India.

## APPENDIX VI

### Improved Varieties for Rainfed Conditions

| *Crop* | *Variety* | *Remarks* |
|---|---|---|
| *Wheat* | | |
| (*T aestivum*) | Kalyansona | Suitable for cultivation under rainfed condition all over the country. |
| ,, | HD 1467 | Suitable for cultivation in the rainfed areas of Madhy-Pradesh, Gujarat, south-eastern Rajasthan. |
| ,, | K. 65 of U.P. | A bold amber grained variety with excellent cooking quality with wide adaptability under rainfed conditions in northern plains. |
| ,, | NI 5439 of Maharashtra | Superior to the local in the rainfed areas of Maharashtra, Mysore and Andhra-Pradesh. |
| (*T. Durum*) | MI 6-23 | Suitable for cultivation in the rainfed area of central India, with attractive bold amber grains. |
| | A9-30-1 | Suitable for cultivation in the black cotton soils of central India, having low rainfall. |
| *Barley* | RS. 6 of Rajasthan | This variety on an average gave 19 per cent more yield over the local check, in central India. The variety has attractive bold grains. |
| | IB 226 | Promising variety for the rainfed areas of central India which gave 15 per cent more yield on an average over the best control. |
| | K 24 of U.P. | Best suited for unirrigated and late sown and medium fertility conditions in northern and eastern zone. |
| *Jowar* | CSH-1 | Kharif areas all over the country with rainfall of 20"-25" ; known for stress conditions ; grow with recommended package of practices. |
| | SWARNA | Kharif areas all over the country with rainfall of 25"-30" ; particularly in |

| | | |
|---|---|---|
| | | black soil areas of M.P., Mysore and parts of Maharashtra. |
| | Exp. Hybrid 2219 | —do— |
| | M. 3511 | Rabi areas of the Deccan in the States of Maharashtra, Mysore and Andhra-Pradesh. *Early sowing in mid-September with carbofuran Treatment of the seed and adequate fertilisation.* |
| *Bajra* | H.B.3 | Limited rainfall areas in Rajasthan, Gujarat south India, etc, |
| Maize | Ganga-5 | Earliest hybrid with wide adaptability ; could be grown under rainfed conditions in areas where about 30" of rain is received during crop growth. |
| | Vikram | Earliest composite available which has *basi* the rainfed open-polinated variety in its parentage. |
| *Ragi* | (Finger millet) IE 901 | Matures in 100-105 days. Yields 23 per cent higher ; adapted to low rainfall in Andhra-Pradesh, Tamil-Nadu, Gujarat, Maharashtra. |
| *Oilseeds* *Castor* | Aruna | Chalka soil areas of Telengana. Early (matures in 150 days against 240 days for earlier varieties). Superior in yields to available varieties, besides some insurance against drought. |
| | Gujarat Hybrid 3 | Earlier than Aruna and stands stress conditions. |
| Safflower Sesame and Groundnut | Locally available varieties | |
| Pulses | Earlly selections of arhar. T1, T21 of U.P. | Stress areas all over the country (Arhar being deep-rooted crop works as a natural plough). |
| | *Mung* T1, T2, T44, T51 of U.P. Pusa Baisakhi | As a catch crop during summer/ kharif to enable double cropping under rainfed conditions. |
| | *Urad*—T.9of.UP. | —do— |
| Cotton | PRS 72 and new early Clustered-boll varieties | Takes less than 120 days, synchronised boll development and greater possibility of increasing plant population. |

Source : Farm Information Unit, Ministry of F.A.C.D. & C.

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